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The Royal Silver Jubilee.

Along with every other loyal British journal, *Discovery* takes pride in presenting to His Majesty King George V affectionate congratulations on the happy completion of the twenty-fifth year of his reign. The period joyfully commemorated this month will be remembered by future generations as the witness of some of the greatest events in the annals of this country. The King's place in history, however, is secure not only by reason of the stirring pageant of his times, but because of the fine qualities he has displayed in the discharge of his royal duties. The best possible tribute to King George V is the habit of his people to take his position as constitutional ruler for granted. It is unquestioned that no constitutional ruler has ever adapted himself so successfully to the moods and sentiments of his people.

The years since 1910 cover a period almost without equal in the history of the progress of knowledge, and His Majesty has watched with a benevolent eye those of his subjects engaged in furthering this progress, never denying encouragement where encouragement was due. Even the War, whose dark years interrupt the peaceful march of the reign, was not without its use for seekers after knowledge. Apart from its direct outcome, by means of which medical and chemical science made great strides, it was followed by a great rush to the founts of learning, and workers were eager to get on with their proper work. The financial crisis of 1931 threatened to wreck the work of years of gradual construction; yet the King's Silver Jubilee is being celebrated in more favourable conditions than the Mother Country and the Empire generally have known for a considerable time. The King, by virtue of his high office and by the example he has set in his discharge of the duties attaching to it, has contributed far more than any other single individual to this inspiriting result. Remembering this, all workers in the field of knowledge join with the rest of the British people in thanksgiving for His Majesty's Silver Jubilee, and in prayer that he may long remain head of the Empire which he holds for them in trust.

Notes of the Month.

While His Majesty has preferred to exercise a general and untiring supervision over the welfare of his subjects, it is worth recording that the direct patronage of science in all its branches was the pleasure of many of his illustrious forebears. The Royal Society was incorporated in the reign of Charles II, who was well known for his interest in the progress of knowledge; George III was himself no mean mechanician; and His Majesty's own grandfather, the Prince Consort, presided over the Aberdeen meeting of the British Association for the Advancement of Science in 1859.

* * * *

The Duke of York will be following a worthy family tradition when he opens the new Museum of Practical Geology on July 3rd this year. The opening of the Museum coincides with the centenary of the Geological Survey of Great Britain, the oldest national survey of its kind in the world, which will now be provided with

adequate and up-to-date accommodation in the new building at South Kensington. On July 4th there will be a morning reception of delegates to the Centenary, followed by an address by the Director of the Survey on the history and functions of the Geological Survey of Great Britain. The same evening there will be a reception by H.M. Government.

* * * *

Like many other public institutions in this country, the Survey owes its inception to private enterprise, and Sir Henry De la Beche, its originator and first director, is commemorated in London University by the De la Beche Club, an informal social club run by the Geology School. The outings of the Club, though their primary purpose is, of course, geological, are by no means the dry-as-dust affairs that the uninitiated layman might imagine, and the good-fellowship of this Club is typical of the spirit of modern Science. The scientist of to-day is far from being the aloof dreamer of a generation ago; he is very much alive to the public interest in his subject and to the public advantage to be derived from it, and one of his hardest tasks is to bridge the gap between the necessary ignorance of the layman and the ever-increasing mysteries that are revealed by research.

* * * *

We have pleasure in extending a welcome to our new contemporary *The Geographical Magazine*, published monthly, price 1s., at 40 Chandos Street, London, W.C.2. The first issue is beautifully produced, both letterpress and illustrations being well chosen and finely executed, and the range of subjects extends from the English Lake District and Amsterdam to Central Australia and India's North-East Frontier. The Editor modestly claims his chief goal to be the enlivening of the dry bones of geographical fact. His first number does more than this: its team of authors manages to impart information in a thoroughly acceptable way—a difficult business with a public that is always suspicious of being "lectured." The names of the authors are a sufficient guarantee that the material is authentic, a virtue which is not an invariable quality of illustrated journals of travel. Major R. E. Cheesman writes appositely on Abyssinia; Mr. J. M. Scott discusses the Arctic Air Route; Mrs. C. P. Grant deals with a very different sort of route across the arid Syrian Desert. It is interesting to know that half the profits made by the magazine are to be devoted to a Fund for the Promotion of Geographical Knowledge, to be administrated by a body of Trustees under the Chairmanship of the President of the Royal Geographical Society. The Prince of Wales, as the Editor is proud to state, has honoured the magazine by consenting to become its first subscriber, and this should be a happy augury for the success of the new venture.

* * * *

The *Museums Journal* reports that the Prime Minister will open at the Science Museum, South Kensington, on May 31st, a Noise Abatement Exhibition, arranged by the Anti-Noise League, of 66, Victoria Street, S.W.1. The Exhibition will remain open throughout June, and will probably conclude with special meetings and conferences. It is proposed to present a comprehensive survey of the whole problem of noise, with the co-operation of the Ministry of Health, the Air Ministry, the National Physical Laboratory, the Post Office Research Laboratories, the B.B.C., and the Industrial Health Research Board, and of a number of industrial research laboratories and firms. A small demonstration house is to be erected, incorporating the latest designs and materials for sound-proofing and sound absorption. There will be demonstrations of silenced pneumatic drills, motor cycles, typewriters, vacuum cleaners, electric motors, circular saws, and so on, and experiments on the value of ear defenders, the masking of noises, the effect of noise on loudness of speaking, and on industry, and the use of noise-level alarms.

An interesting arrival at the London Zoo. "Jubilee," the first chimpanzee ever born in London, poses for her portrait while her mother "Boo-boo" receives a visitor.

History in the Reign of George V.

By R. B. Mowat.

Professor of History in the University of Bristol.

In a brilliant and scholarly way Professor Mowat here summarises the progress of historical knowledge in a period itself of the greatest significance in world-history. How the historians of to-day have met the demand for the explanation of human affairs is a subject of the greatest importance and interest.

THE term "history" embraces the whole story of mankind, but in this essay it will be limited to "modern history," that is, to the record of mankind since the fall of the Roman Empire, generally dated at A.D. 476. Ancient Greek and Roman history, archæology, the work of the papyrologists, anthropology, and spelæology, will all have to be left out of the survey.

And by "history" further, is understood not only the record, but the interpretation of life. This, indeed, is what it was in the Victorian Age. "Two generations back," writes Professor Trevelyan, "history was a part of our national literature, written by persons moving at large in the world of letters and politics. Among them were a few writers of genius, and many of remarkable talent, who did much to mould the thought and inspire the feeling of the day. Of recent years the popular influence of history has greatly diminished. The thought and feeling of the rising generation is but little affected by historians. History was, by her own friends, proclaimed a 'science' for specialists, not 'literature' for the common reader of books. . . . Until quite recent times, from the days of Clarendon down through Gibbon, Carlyle, and Macaulay to Green and Lecky, historical writing was not merely the mutual conversation of scholars with one another, but was the means of spreading far and wide throughout all the reading classes a love and knowledge of history, an elevated and critical partiotism and certain qualities of mind and heart."[1]

A Tradition of Scholarship.

All this is true. By the end of the 19th century history was becoming technical, highly specialised, "the mutual conversation of scholars." By the time George V came to the throne, the fashion seemed to be absolutely set. In particular the history of the Middle Ages had become largely a matter of spadework, of minute research. And although splendid work has been done in mediæval scholarship, there is very little of it which the ordinary, intelligent reader cares to read, and its popular influence is almost nothing. Wylie's big *History of Henry V* (1914-29) is a work on the grand scale (three volumes), fully documented, picturesque and eminently readable. Miss Helen Waddell's *Wandering Scholars* (1927) is a work of rich and ample scholarship, of style and imagination, which, like all the best history, has the vividness of life because it proceeds from life itself, not from the dead bones of the past. T. F. Tout made minute and elaborate researches into English administrative history of the 14th century; his successor as Professor in the University of Manchester, F. M. Powick (now Regius Professor at Oxford), maintained the distinction of the "Manchester School." Pollard's *Evolution of Parliament* (1920) carried onward the tradition of scholarship in constitutional history established in the reign of Queen Victoria by Bishop Stubbs.

[1] G. M. TREVELYAN, *Clio, a Muse* (1913), pp. 1, 5.

The Grand Style.

The Victorian Age had produced narrative histories in the grand style and of great length, Macaulay, Freeman, Froude. S. R. Gardiner endeavoured to continue this tradition in his long and scholarly history of the reigns of James I and Charles I, a task for which he had the necessary industry and erudition, but not the style nor the imagination. Gardiner died in 1902. His work was continued by Charles Harding Firth, who has as great knowledge of the 17th century as Gardiner, and a much superior literary faculty. It may be said that with Firth and also with Fisher (whose *Mediæval Empire* came out ten years before the reign of George V) historical research became again literary. Mr. Fisher's *History of Europe*, of which Volume I has recently been published (February, 1935), is a work of high artistry, thoughtful and vivid, a sustained narrative without exaggeration or paradox.

The Georgian era has produced military history of high quality, indeed the highest since A. W. Kinglake wrote *The Invasion of the Crimea*. J. W. Fortescue's *History of the British Army* came in seven volumes, between 1910 and 1912. It is a work not only of deep research in military archives, but also of vivid imagination and in certain passages almost inspired. Fortescue had strong feelings and prejudices; he had also some genius, and in his pages the armies of Queen Anne and of the Georges live again their incomparable days of splendour and distress. In addition to Fortescue's work the British Army has been studied in detail by Sir Charles Oman throughout its actions in the Peninsular

War, with English, French, and Spanish authorities carefully weighed, and the topography and all the military movements lucidly and comprehensively explained. Oman's influence at Oxford is also found in the military histories of C. T. Atkinson, Fellow of Exeter College. The World War is being written at full length in an official history which is much more than a technical military work; General Edmonds's volumes are clear and convincing, and, because of their sincerity, unconsciously picturesque—the best type of Staff history. Liddell Hart has written with knowledge, vigour, and critical power on certain aspects of the War. And in one closely-packed volume, C. R. F. M. Cruttwell has concentrated the whole story of that moving tragedy with realism and passion, combined with high impartiality and restraint.

The Macaulay Tradition.

It almost appeared as if history in the grand style, as conceived and expressed in all its amplitude by Gibbon and Macaulay, was impossible in the mechanical and scientific age which is the 20th century. Only one man has boldly appealed to the Macaulay tradition, and has deliberately set out to write history, based on profound research, in the grand style: in the full narrative, the pen portraits, the moral judgments, the social atmosphere, the large humanity with which the masters wrote. Before he set out upon this effort, Mr. Trevelyan had already produced three books on the making of modern Italy—*Garibaldi's Defence of the Roman Republic* (1907), *Garibaldi and the Thousand* (1909), *Garibaldi and the Making of Italy* (1911)—which are a splendid description of that stirring time and great emotional movement. The three volumes on *England under Queen Anne* are of a different kind. They do not trace a single movement like the *Risorgimento*; it is a whole reign, in its complete domestic and external aspects—that is the theme. And this theme is dealt with amply, richly, with copious extracts from documents, numerous references and notices, narratives of parliamentary history, social history, the economic factors, maritime affairs, military affairs, embassies, court intrigues, the law, the state of foreign courts and sovereigns and their ministers—in a word, politics in the big sense in which Gibbon or Macaulay understood them, as the doings of the people, but with the emphasis on the statesmen and captains and on the activities and vicissitudes of the Court and the camp. Mr. Trevelyan loves the party-game of the Whigs and Tories, understands the political personalities, appreciates the great literary figures, sets Queen Anne in her proper place as the Patriot Queen after the pattern of Bolingbroke, and expounds with loving amplitude the grand act of British 18th century statesmanship, the Union of England and Scotland. Nevertheless, notwithstanding all his politicalness and his zest for the letters and society, the clubs and coffee-houses, of the Augustan Age, it is in the campaigns and battles that Mr. Trevelyan is happiest. Though his history is a history of a whole reign in all its many-sidedness, he has a central theme and a central figure: the War on the Continent and Marlborough. The Great Captain with the sunny nature and the genius that commands success; and the light-hearted red-coats that marched with him from the Scheldt to the Danube, to the astonishment of their bewildered allies and baffled enemies, are the "argument" of Mr. Trevelyan's epic.

Mr. Trevelyan is a professional historian, grown up amid the highest literary and scholarly tradition, undergraduate, university prizeman, Fellow of his College, drawing all that is best from academic life. Mr. Churchill had no such advantages, yet he has produced the other big book of "Georgian history," and, curiously enough, on the same theme as Mr. Trevelyan's book, Marlborough.

Anne and Marlborough.

Mr. Churchill has written a notable biography, of which two volumes have been published. He has the rare faculty of infusing into his prose a quickening spirit. What he writes is always interesting. The narrative moves. The vividness of the narrative is, in vol. ii, supported by a marvellous wealth of clear maps. The great figures stand forth boldly and clearly from the background of the Age. By direct research and through helpers he has sifted a great deal of material. A keen House of Commons man, Mr. Churchill appreciates parliamentary history, and has good remarks on it. In a few pages in the first volume he analyses the siege technique of the late 17th century, with its half-moons, ravelins, glacis, covered ways, and the rest, and makes it all mean something to the reader. He is not uncritical of Marlborough's character, though, naturally, the Duke is a hero to him; as he is also to Mr. Trevelyan. The two works, Trevelyan's *Queen Anne*, Churchill's *Marlborough*, are in the grand style, and on the big scale, the epic of one of England's and Europe's grandest periods. Politics of the 18th century have been brilliantly illustrated in Namier's *Structure of Politics in the Reign of George III*, and by Sir Charles Grant Robertson's *England under the Hanoverians*. The investigation of Britain's colonial policies of the 18th century and later was carried out with great industry, skill, and judgment by H. E. Egerton, and after him by A. P. Newton. P. E. Roberts has done valuable work on British-Indian history. A contribution to early 19th century history is *The Age of Grey and Peel* by H. W. C. Davis, whose

untimely death took from Oxford one of its most devoted and beloved teachers. Large-scale history of a rather earlier period, England during the Napoleonic Wars, was successfully undertaken in two large volumes by A. F. Freemantle.

A remarkable feature of historical work in the present reign is the big series of "Lives and Letters." It is an age of long biographies, which include regular collections of letters. The first of the series was Morley's *Gladstone*, a solid piece of work written by a philosopher who was also a statesman. It is not completely successful either in its picture of Gladstone or its appreciation of the problems of his time, yet it is a fine effort. More successful, perhaps because more "intimate," is Monypenny and Buckle's *Life of Lord Beaconsfield*, which discloses Disraeli familiarly in letters written from and to him, and sympathetically and elaborately narrates every aspect of his active life. Lady Gwendolen Cecil's *Life of Robert, First Marquis of Salisbury* is scholarly, graceful, and full; Garvin's *Life of Joseph Chamberlain* is a vigorous account of a tremendously vigorous and dynamic, if not always judicious, statesman. There are many other long and comprehensive "Lives and Letters" which are now providing the reading public and historians with unexampled opportunities for knowledge. Curiously, this kind of historical literature is almost completely lacking abroad, even in the United States,

H. W. V. Temperley.

although Hendrick's *Life and Letters of W. H. Page*, and R. S. Baker's four-volume *Life of Woodrow Wilson*, are notable instances. English scholars have also handled the short (or comparatively short) biography form well

G. M. Trevelyan.
[*Messrs. Elliott & Fry, Ltd.*

in, for instance, Lord Charnwood's *Lincoln*, Grant Robertson's *Bismarck*, Neale's *Queen Elizabeth*, and Basil Williams's *Rhodes*. Colvin's *Life of Jameson*, on a somewhat larger scale, is a notable picture of South African life and politics in a fateful period.

Besides many-volumed "Lives and Letters," the reign of George V has added to historical literature a whole category of memoirs of a novel kind. There have been other times when memoir-writing was fashionable, particularly the reign of Louis XIV and the Age of Napoleon. Most of the memoirs of these times were written by soldiers; few were the works of the first-line statesmen; and many of them were largely concerned with social affairs and second-rate politics. But the post-war period of George V is distinguished in historical literature by the voluminous personal records—diaries, reminiscences, confessions, and defences—of leading statesmen who directed policy in the World War. The volumes of Grey, Asquith, and Lloyd George, especially the last, throw a perfect flood of light on the politics of the War; the controversy aroused by Mr. Lloyd George's account of the battles of Passchendaele, and his astonishingly vigorous, relevant, and pointed defence of himself in *The Times* correspondence on the subject, have added very considerably to knowledge. The Diaries of General Sir Henry Wilson, of Lord Riddell, of Dr. Addison, Mr. Churchill's *World Crisis* (partly reminiscences and collections of documents, partly narrative history), are of first-rate importance to the historian and of high interest and educational value to the general reader. In a different class, but in some respects comparable to memoirs, are "histories of my own times,"

like that which two hundred years ago Bishop Burnet, both scholar and statesman, wrote of the reigns of James II and William III. J. A. R. Marriott, Oxford tutor and Member of Parliament, has written an impartial and informing *History of Britain* in his own active life-time. *The Social and Diplomatic Memories* of Sir Rennell Rodd, Lord Rennell (1922-25), are a beautiful instance of the old type of memoir, informing but discreet, not avoiding strictly contemporary history.

Diplomatic Secrets.

Another type of history which has been developed in the present reign is diplomatic history. There have been previously, chiefly on the Continent, studies of the art or technique of diplomacy, and one or two long histories of the profession or its achievements. These were isolated efforts. In the last twenty-five years, however, diplomatic history and practice has been seriously studied by a number of scholars and has been brought to the understanding of students and also of the reading public who formerly regarded it as something remote and mysterious. This study and knowledge of treaties, of their negotiation, and of the diplomatic relations between states and of the method of the diplomatists and foreign offices, has been promoted by the diplomatist Satow (*Manual of Diplomatic Practice*); by Temperley and Webster in their works on Canning and Castlereagh; in Temperley's *History of the Peace Conference;* by Toynbee's *Surveys of International Affairs* (sponsored by the Royal Institute of International Affairs); by the studies of English diplomacy at certain periods made by Sir Richard Lodge and Basil Williams; by L. G. Wickam-Legg's selections of 18th century Instructions (Royal Historical Society); by Harold Nicolson's charming and wise studies of *Lord Carnock, Peacemaking* 1919, and *Curzon;* by Seton Watson on Central Europe and the Southern Slavs; by Gooch's *Recent Revelations of European Diplomacy*; and, if the reference be allowed, by the present writer in a series of histories of European Diplomacy. Although not in the "English" school of diplomatic historians, mention must in fairness be made of American contributions; particularly of the work of Charles Seymour, of Yale University, whose *Intimate Papers of Colonel House* and other diplomatic works have added greatly to knowledge and interest; and of the studies on the origin of the World War, of S. B. Fay and Bernadotte Schmitt.

The study of diplomacy, as well as the search for historical truth, has notably gained from the publication of *British Documents on the Origins of the War*, edited by Gooch and Temperley. In addition to their frank publication of state papers for the period 1897-1914, the editors have published the official minutes or comments on despatches. Some of these minutes, like those of Eyre Crowe and Hardinge, created a great stir when they were read outside the Foreign Office.

Men of letters have been writing history. Both Mr. Belloc and Mr. Chesterton have written a History of England which is enriched by their characteristic styles and imagination. Mr. Buchan has written sympathetic studies of Montrose and Cromwell. Mr. Guedalla's *Second Empire* and *The Duke* have vividness and scholarship. Mr. Bryant's *Charles II* and *Pepys*, written with much grace and charm, are based on wide knowledge of the records of social history. The work of a professional historian, Mr. Ogg's *Charles II* is a work of research on an elaborate scale, successfully achieved; and the domestic politics of the late 17th and early 18th century have been investigated by Mr. Keith Feiling, whose *Early History of the Tory Party* explains the development of political principles, practices, and personalities with learning, ease, and impartiality.

History on the Stage.

Historical playwriting has had considerable vogue, and has attained a high quality of poetic interpretation in Drinkwater's *Abraham Lincoln*, Shaw's *Saint Joan*, and in a play which, as acted, attained remarkable popularity, Gordon Daviot's *Richard of Bordeaux*. *Saint Joan* is a work of philosophy as well as of imaginative history; the tragic note in it is not very pronounced; it is, on the whole, an optimist interpretation of history. Among "war plays," Sherriff's realistic and deeply impressive characterisation in *Journey's End* puts this work in a class by itself.

The Cambridge University Press has followed up *The Cambridge Modern History*, which was completed before the reign of George V, with large "co-operative" histories of India, the British Empire, and the Middle Ages, all of them, in their way, a memorial of the influence of Lord Acton, who died before the first volume or the series which he planned had appeared. The Oxford University Press has in hand a large scale History of England, fourteen volumes by various authors, of which the first published volume (1660-1714) is by the general editor, Professor G. N. Clark.

The survey of "Georgian" historians provides a record of solid and workmanlike, frequently also of artistic, achievement. There is something accidental about genius; a genius may, or may not, be born in any Age. Gibbon is the peculiar glory of historians of the 18th century; Macaulay of the 19th. The reign of George V can at any rate show a large number of works of high quality, and two or three of genius, even if posterity will not place them on the same shelf of fame with Gibbon, or continue to regard them as lovingly.

In comparing, too, the achievement of historians now and in the time of Gibbon, we have to remember that the population of Great Britain to-day is about eight times what it was then, and that education is far more widespread. Relatively to the populations, historical writings are more numerous, but not strikingly more numerous, than they were in the reign of George III.

History as written now is correct and honest craftsmanship. Much of it is work of very considerable distinction. It must be borne in mind that, in regard to modern times, there is not, perhaps, a very great deal to "discover," in the sense of scientific discovery of hitherto unknown facts or laws or processes. Most of the great events or developments of the last four or five centuries are in a sense already known, or have been known, not to everybody, but to somebody; the archives are in existence, and in great part have been already read by somebody; and those that have not been read may, when they are read, in many cases not very materially alter our idea of the past, although, of course, there is room for any amount of original work, based upon original documents, published and unpublished. The writing of "modern" history is not so much a work of discovery as a work of interpretation. It requires vision, imagination, sympathy, and power of philosophic thought as well as knowledge; it is poetic. And it is the historians' interpretations of facts which alter our idea of the past. Discoveries, indeed, are made, like Mr. Hilary Jenkinson's finding of the writs of the Easter Parliament of 1275, brought to light in 1910, and Mr. Arthur Bryant's recent finding of Pepys's journals; and such discoveries are always exciting. Nobody, however, would call Trevelyan's *Anne* or Churchill's *Marlborough* discoveries; yet they are history in the best sense of the term. I do not think that this work of interpretation of the past has made very great advances in the reign of George V. And the reason for this may be that fewer historians are classically trained than was the case in the 18th and 19th centuries when, indeed, they were all classically trained. Gibbon and Macaulay, Stubbs, Freeman, Froude, and Green were all brought up on the classics. Now a classical training has two advantages for historians; it makes them undertake an effort to understand, by reading authentic documents, the remote past, and so trains them to understand a more recent past. And secondly, classical learning, if carried into Greek philosophy, inclines the scholar to a philosophic outlook. History is only life, and life can only be understood through a philosophical attitude, experience and thought. It has been left to the Italian contemporary of the "Georgian" historians, Benedetto Croce, to point out the necessity of philosophy for the study of history.

Physics since 1910.

By A. S. Russell, M.A., D.Sc.

Student of Christ Church, Oxford.

The volume of literature on the progress of Physics in the last twenty-five years has been, inevitably, enormous; and the interested layman has often been bewildered. Dr. Russell here sums up the position in a way that could hardly be bettered for clarity, leading up to that strange principle of Indeterminacy which involves the observer as well as the observation.

The twenty-five years of King George's reign over us mark better than arbitrary periods of this kind might be thought to do, a very definite stage in the development of physics; of physics both on its experimental and theoretical sides. It has been a very great period indeed. There is only one earlier time to be compared with it in importance and interest—the decade which began in 1895. Then were discovered the X-rays (late in 1895), the real nature of the electron (1897), radioactivity (1896) and the new elements polonium and radium which came in its train (1898); in theory, the quantum ideas about energy (1900). In this period young Mr. Marconi made wireless transmission a technical and commercial affair. The still younger Professor Einstein brought out in 1905 his special theory of relativity with its insistence on the one absolute "space-time" instead of Newton's pair, absolute time and absolute space, and this theory was destined like the quantum theory to open up physics amazingly. In the everyday world the internal combustion engine took on a new lease of life. Whereas before November, 1896, a motor car might not go on the high roads of our land without a preceding red flag, in December, 1903, a machine in the United States, carrying a man, had raised itself in the air by its own power in free flight.

The present period in physics is one in which these earlier beginnings have developed in their unexpected way. If one sentence could summarise its general tendency it would be that we are moving from the simple, naive, "common-sense" world of appearance towards

the complex, seemingly symbolical, odd, world of reality. With all the strangeness, with all the paradox, we have got much nearer to what we are trying to look at. An enormous lot of detailed knowledge has been acquired by hard effort aided by a wide range of ingenious instruments and the explanation of much of this has been embodied in new and striking theories. To those immersed in the matter none of the detail is dull; occasionally they think the theories about it might well be duller in being less strange or paradoxical. Where have the chief advances occurred?

The Structure of the Atom.

First, in knowledge about the atom, and by two main techniques: bombardment of atoms by swift particles, and by various kinds of spectroscopy. The atom, we are constantly being told, was always envisaged in the 19th century as a billiard ball; it was only in this century that it was regarded as something with a structure. In 1913 it was found that at the core of every atom was a nucleus containing practically all the atom's mass and bearing a positive charge. By 1919 it was found that this nucleus could act as a target to a certain projectile: the swift, doubly-charged atom of helium. And the result of the impact was the ejection of a charged atom of hydrogen and the production of a new nucleus, the nucleus of another element. This was the beginning of what is called the artificial transformation or transmutation of elements; by bombardment one element could be changed into another and from this clash much could be learned. There are now four particles, instead of one, with which to bombard; one of the most recently discovered of these—the neutron—promises to be the most important of the lot. Whereas in 1919 only a few of the lighter elements were amenable to this transmutation, in 1935 all but the very heaviest can be broken up, and some of them break up in an interesting variety of ways. The variety, indeed, is so bewildering that it is almost becoming a joke. The upshot of all this is that we are getting a real knowledge of that little world-in-itself, the atom, which was never suspected, much less capable of being investigated, by an earlier generation of physicists. Spectroscopy also is making a large contribution to the problem. The structure of the nucleus, the relation of the nucleus to the electrons which move round it like planets round a central sun, the curious principles which are obeyed by each, the effects which physical agencies produce on the "innards" of the atom—all are becoming increasingly important for an understanding of what physics is. It should be added "increasingly bewildering," not merely to the layman but to specialists themselves unless their speciality is the atom. There are terrifying terms like "Pauli's principle," the "Raman effect," the "Compton effect," "forbidden spectral lines," and "transition probabilities" which, while commonplaces to many, are only now ceasing to be meaningless to nine scientists out of ten. The great leader in this work has been and is Lord Rutherford.

Molecule Patterns.

A second great advance has been in our knowledge of the structure of the simplest units—the molecules—of the simpler compounds with which chemists and physicists busy themselves. This has been made possible by the X-rays. It was only about 1912 that the X-rays were found to be a wave-motion essentially the same as light but with a wavelength about ten thousand times smaller. One of the reasons why we cannot see what a simple chemical compound like common salt is composed of is that the light we require for sight happens to be ludicrously too gross to view so very delicate a thing. But the wavelength of ordinary X-rays is sufficiently small to show up the kind of structure such compounds have. If a crystal be examined with X-rays it is possible to detect the presence of parallel planes of atoms in it and to determine the distance between them. And by elaborations of this, sizes and distances in the world of the crystal may be estimated with considerable accuracy. The result has been that the orderly arrangements of atoms (or of charged atoms) in metals, in elements generally, and in their simpler compounds are now thoroughly known and this knowledge is not only interesting in itself but is found to have an important bearing on the physical properties of these substances, such as opacity or transparency, electrical conductivity or ability to insulate, hardness, strength, and the like. The reason why one form of carbon, diamond, is hard and transparent, and another, graphite, opaque and soft, has been very satisfactorily correlated with the arrangement of the atoms of carbon in the structures of these two essentially identical but dissimilar substances. By now thousands of compounds, both in inorganic and in organic chemistry, have been examined by this X-ray technique. The patterns in which the atoms or charged atoms are arranged are often called lattices. There are "face-centred" lattices, and "body-centred" lattices, "hexagonal close-packed" lattices, and so on. Here has arisen a jargon which no longer can be confined to the student of crystals. The student of inorganic chemistry, the student of physics, as well as the student of crystallography, must have a working knowledge of what these terms mean and what is the importance of the thing itself for the particular work in which he is himself interested. The pioneers of this work were Sir William Bragg and his son, Professor W. L. Bragg.

The greatest generalisation in physical theory in the

period has been the extended or generalised theory of relativity which Professor Einstein brought out in 1915 —a bold attempt to explain all that is occurring in the material world in the simplest possible way; not, as it happens, simplest from the point of view of immediate apprehension in terms of words of one syllable, but simple because of the fewness of the underlying postulates about the universe. In particular an explanation was found for the " force " of gravitation. Gravitation has always stood outside the main stream of knowledge which flowed from Newton's laws of motion, mysterious, isolated, unexplained. In his theory Einstein postulated a " curvature " in the space-time continuum which rolled the whole continuum up into a kind of closed surface as, say, the whole surface of our Earth is rolled up into a closed sphere. He also postulated much smaller local irregularities superimposed on the main curvature. These smaller ones were associated with the presence of matter and were responsible for the observed curvatures of, say, the path of a planet round the sun or of a ray of light. In a word gravitation was not regarded as a force but as a property, a geometrical property, of the space-time continuum in which our lot is cast. It is a consequence of Einstein's theory that space cannot exist without objects whereas it was one of Newton's best points that objects could not exist without space.

Einstein's theory has quite definitely overthrown Newton's. Its merit lies in that whenever the deductions from it have appeared to be in conflict with those deduced from Newton's system, the latter have been found experimentally in every case to be wrong, and the new laws postulated by Einstein's theory to be right. For more than two hundred years after its inception the Newtonian system served to explain perfectly the motions of everything on the earth and in the heavens. It is interesting that in our time—and during the War—it should have been so finally overthrown.

The Expanding Universe.

A consequence of Einstein's theory is that our universe of space-time is finite and closed; there is only a finite amount of matter in the universe—literally everything, literally everywhere. And from this supposition experiment and theory have led astronomers to believe that this universe is expanding with time. Everything in it is getting farther away from everything else, the things farthest away moving off fastest. As an example, nebulæ so distant that their light takes about 135 million years to reach us seem to be receding from us at the colossal rate of 15,000 miles a second! It would seem that about 10,000 million years ago our universe was a nice little, tight little affair. Since then this assemblage of space and matter has been widening out, doubling its diameter regularly every 1,500 million years or so; so it may go on doing till the end. Only in recent years has it been realised that the universe is " running down " (though the evidence for this is eighty years old), moving inevitably from a state of high organisation and available energy to one of low organisation and " unusable " energy. On present knowledge what an extraordinary beginning the universe must have had! What an extraordinary end it is heading for!

Indeterminacy.

One of the most interesting theoretical points which have arisen in physics since the War is the Principle of Indeterminacy of W. Heisenberg. On ordinary, large-scale, everyday processes the prediction of effect from cause in the material world can be carried out with very great accuracy, but in the atomic world the exact prediction of the future of the particles down there has been found to be impossible. An observer furnished with the finest resources of a laboratory, himself a walking encyclopædia of fact, with all Laplace's or Einstein's mathematical gifts, cannot so observe a particle as to predict what must happen next. The gist of the reason for this is that no one can observe the course of Nature without interfering with the course of Nature. It isn't clumsiness; it isn't incompetence; it is inherent in Nature itself. Suppose someone observing a particle wishes to know exactly where it is at a fixed time and what is its velocity at that fixed time. It is always found there is an uncertainty attached to his joint a observation of positionnd velocity. He can observe one very exactly but that leads to the other one being less accurately observed. The more accurately one is observed the less the other. The uncertainty can be split up at will between the two observations—allotted in this case either to velocity or position or both—but it cannot be eliminated.

While these are some of the more important advances in pure physics in the period there are others which can merely be named here. Isotopes, that is to say, the discovery that a chemical element may have atoms identical chemically but in certain physical properties very different. The Cosmic Radiation, a penetrating radiation impinging on us from outside the solar system, consisting partly of charged particles and partly of ordinary radiation. The new planet Pluto. In theory, the wave-theory of matter. And the period has been outstanding in the increasingly successful application of older ideas and inventions to the needs of man. One has only to think of that major event in the intellectual history of mankind: the rise of broadcasting; or of television, the modern car, or the modern aeroplane.

Twenty-Five Years of Biology.

By C. H. Waddington, M.A.

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Biology has advanced perhaps more markedly during the present reign than almost any other department of Natural Science; and here as elsewhere investigators find themselves on the threshold of deep mysteries. The creation of life remains, and is likely to remain, unattainable by Man, but he has been able to carry out part of the evolutionary process experimentally. The story of the advance to this point is the fascinating theme of Mr. Waddington's article.

In the last twenty-five years there must have been not less than 10,000 people working full time on biological research. In this article there is only one word to represent a hundred or more man-years of effort: obviously we must consider only the most general problems.

Twenty-five years ago biology was emerging from a phase in which it had been mainly concerned with describing living organisms. The description had beens more or less completed, not only of the gross shape of the various organisms, but also of their microscopic structure and of the main functions which their organs perform. In the modern period there has been a great development of those branches of biology which attempt to discover the mechanisms underlying these appearances and functions. At first it seemed that there was no hope of formulating adequate biological laws until one had decided, on general philosophical grounds, the kind of concepts to be employed. This question was energetically debated by the mechanists, who argued that one should attempt to account for biological phenomena by the behaviour of physical and chemical entities, and the vitalists, who maintained that it would be necessary to employ specifically biological ideas as well. Further thought has gradually resolved the contradiction between these two views, and the controversy is no longer the growing point of biological thought.

The Pattern of Nature.

The way out of the dilemma was provided by the idea of organisation or arrangement in a pattern. If we study two things, keeping them always isolated from each other, we can write down a set of definitions which are descriptions of their behaviour: but if we subsequently find that they can combine in a stable arrangement, we often find that the stability of the arrangement depends on properties which had previously been overlooked, and we shall then have to add something to the original definitions. For example, the physicists, studying the properties of electrons and protons as they emerge separately from a radioactive substance, did not guess that when they are combined into an atom there are only certain orbits in which an electron can rotate round a proton. That information came from the investigation of the actual patterns found in electron-proton combinations, and it involved an addition to the previously known properties of these bodies.

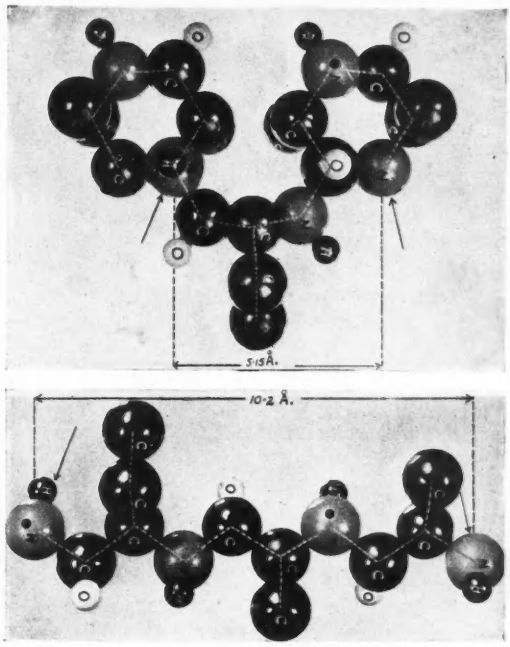
In living organisms the chemical elements are certainly combined in complicated arrangements, and we may therefore expect that some at least of these arrangements are stable patterns which depend on relations which we have not yet grasped. According to this view the mechanists were wrong when they insisted that the physical and chemical concepts which we now employ are sufficient to explain biological phenomena, and the vitalists were wrong when they urged that we shall have to add new non-physico-chemical ideas: what we shall have to do is to alter the definitions of the physico-chemical concepts For instance, consciousness is clearly bound up with a material system, a system finally of electrons and protons, or wave functions, or whatever the physicist accepts as the last stage in his analysis. But none of these physical concepts have any characteristics which are commensurate with self-consciousness. When we have discovered what particular arrangement of the fundamental physical elements gives rise to consciousness, we shall be able to add the necessary property to our present definition of the physical concept.

Photographing Proteins.

The sort of biological research which is most important from a theoretical point of view, is, then, the search for new types of arrangement or organisation. We can only mention a few examples here. The lowest order of organisation which we need consider is just more complicated than the ordinary arrangement of atoms dealt with by chemists. The proteins, which always make up a large proportion of a living organism, are compounds of such complexity that ordinary chemical methods of investigation have not been able to provide a satisfactory explanation of their properties. A new method of analysis, that of X-ray photography, has recently been applied to the problem and has already yielded results of the greatest importance for biology. Astbury has shown that the proteins of hair are arranged in long strings side by side with sufficient regularity to give X-ray photographs comparable with those obtained from

crystals. He has been able to deduce from the photographs the exact positions of the atoms in hair-protein, and has shown how the particular pattern explains some of the physical properties of hair, such as its extensibility and reaction to wetting, etc. This work not only has great theoretical importance, as an example of the way in which protein structures occur in living material, but is also of considerable technical importance in wool spinning. There are many possibilities implicit in this method of approach. As yet very few biological substances have been analysed by X-ray methods, and so far they have mostly been the simpler substances which are formed as cell coverings or other more or less " dead " and inert by-products, like hair or silk or the cellulose cell walls of plant tissues. But a beginning has been made with the structures of " living " active cell material, and it has been found, for example, that when muscle contracts, its proteins undergo the same sort of crumpling up into a shortened form which was discovered in the contracted state of hair. We have here a method which may eventually be able to elucidate many biological problems, such as the mechanism by which the cell regulates its enzyme reactions and the way in which an egg-cell is able to develop into the complicated structure of an adult.

Meanwhile, biologists have been discovering new units more complicated than proteins. There are the obscure bodies known as bacteriophages and filterable viruses and, probably belonging to the same order of complexity, there are the hereditary units or genes. We know very little about the structure of these bodies, but they all share one important property which is not found in the proteins: they are able to reproduce themselves and increase in quantity, if given a suitable environment. We have no certain knowledge of how they do it, but one can presume that the particular arrangement of atoms leaves over a residual field of force which attracts other atoms in the neighbourhood and arranges them into a replica of the original compound. As yet the greater part of our knowledge of these entities is concerned with their importance in biological phenomena, which can, of course, be investigated without any detailed knowledge of their inner structure. In fact, the broadening and deepening of our understanding of the behaviour of genetic factors is probably the most obvious advance in biology in the last twenty-five years. It has been shown that the genes, whose interactions seem finally to control all the properties of the living organism which contains them, are arranged in a linear order on the chromosomes in the cell-nucleus. Just recently it has been found that in some special cases, particularly in the salivary glands of insects, the chromosomes are very much larger than they usually are and show cross-striations which indicate the position of one or a small group of genes. A new line of attack on the nature of the gene is now starting from this discovery. Already it seems probable that a higher order of pattern has a special importance, since Muller and Prokofieva claim to have shown that the characters of an organism are affected not only by the particular arrangement of atoms into genes but also by the particular arrangement of genes into groups. It is possible that these expanded chromosomes will prove to be large enough to be investigated by physical and chemical methods which so far have been technically out of the question.



Models of a small section of a keratin molecule (contracted form above, expanded form below), made up of carbon, nitrogen, oxygen, and hydrogen atoms. Note the positions of the nitrogen atoms indicated by arrows.

(*From Astbury's "Fundamental Structure of Textile Fibres," by courtesy of the Oxford University Press.*)

All the units which we have mentioned above are of a fairly low order of complexity. An actual living organism is itself an arrangement of proteins, genes, etc., into a pattern of a higher order. Even without a full knowledge of the elements out of which it is made, we can begin to find out something about the nature of this pattern. We seem, as was said above, nearly to have reached the limit of straightforward description of living structures, although new technical methods are still being invented which reveal more details than had pre-

viously been visible : an example is the use of ultra-violet light in micro-photography, which both makes possible a greater discrimination of the shape of very small objects and also shows up some features of cell anatomy much more clearly than ordinary light. But we can also deduce something about the nature of the organisation of living matter by studying its behaviour, that is to say, the functions it carries out. The study of biological function is now in its heyday. Every year, almost every month, brings new discoveries of the greatest importance about the way in which living organisms work. It is only necessary to mention the discovery of vitamins, the investigation of nerve impulses or of muscular contraction, or the gas exchanges of plants, to indicate the sort of research which falls into this category and its fundamental importance for our understanding of the processes going on in living things. But although we can find out what processes can and do go on in a given structure such as a nerve fibre or a system of heart, blood-vessels, and lungs, this method of attack does not reveal what are the links which bind the proteins and other elementary bodies into just that pattern which constitutes a particular organ.

We can find out rather more about the relations on which the pattern is based by studying the changes of which the pattern is capable. The organisation of living things changes during embryological development and during evolution. In the first case the unit which changes is the organism itself, in the second it is the group to which the organism belongs. We will consider the embryological change first.

Stimulus and Reaction.

During development from an egg-cell to an adult, two kinds of change are involved. One is a change of the arrangement of the living matter into cells and tissues of different types, the other is a change in the arrangement of these cells and tissues into a complete animal. Both kinds of change usually proceed at the same time, and they are probably closely connected, but in analysis of the problem it is necessary to consider them separately. An alteration in the histological type of cells and tissues seems to be produced by some stimulus being applied to the cells while they are in a reactive state. In many cases the stimulus is chemical in nature. There are examples of the same kind of interaction in adult tissues, as, for example, when the female sex hormone causes alterations in the cells of the walls of the uterus and vagina. We already know the chemical constitution of some at least of the sex hormones, and, oddly enough, it has been found that some other compounds, which are only rather vaguely similar in constitution, can produce the same effects. Clearly the particular effect is determined not by the exact nature of the stimulus, but rather by the kind of reaction which the tissues are able to undergo ; it is as though the tissues were unstable but could be caused to change only in a restricted number of ways. Exactly the same is true in embryological development. The " hormones " in this case are known as evocators, and the best investigated is the evocator which causes the ectoderm of the amphibian gastrula to develop into nervous tissue. In this case the ectoderm is continually changing through internal causes and is only reactive or " competent " during a certain period of its existence, but within this period several different substances can cause a nervous differentiation. Most remarkable is the fact that some of these substances are identical with those which act as sex hormones. Substances of a similar type also act as hormones or evocators in another very important type of histological change, namely in one of the ways in which normal adult tissues change into cancer tissue.

Building the Embryo.

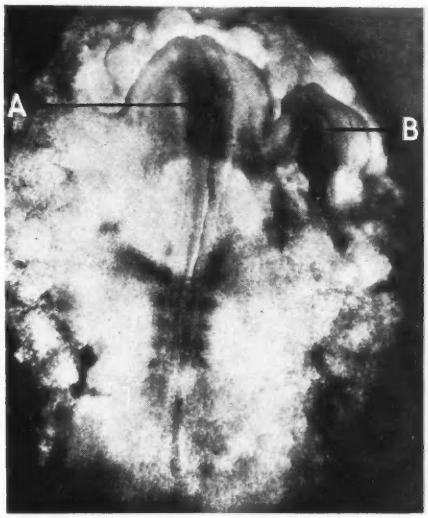
Changes of the way in which tissues are arranged to form complete organisms do not occur naturally to any large extent, except in the formation of cancer, which involves the breakdown of the normal organisation, and in embryological development when the normal organisation is built up. Experimental embryology has shown that the building up of the normal organisation of a complete animal or of a particular organ is usually performed in relation to a definite centre around which the tissues are arranged. Spemann, who discovered these centres 17 years ago, named them organisation centres. If, for instance, an organisation centre is grafted out of its usual place in an egg into new surroundings it will cause those new surroundings to develop into a complete embryo or complete organ. This " induction " of a new embryo involves both sorts of embryological change ; the production of new sorts of tissues by the action of evocators formed in the organisation centre, and the arrangement of those tissues into the right places to form the organ in question. Just as the kind of reaction to the evocator depends on the nature of the reacting tissue, so does the way in which the tissues are arranged. The classical experiment is one in which a newt mouth-organisation-centre was caused to induce a mouth in frog tissue ; the frog tissue responded to the evocator by forming frog mouth-tissues, which were arranged round the centre in the shape of a frog's, and not a newt's, mouth.

Both the types of embryological pattern-change are therefore to some extent similar. The old arrangement becomes unstable, and a new arrangement is formed in response to a stimulus coming from outside, rather as a

crystal forms out of an oversaturated solution when a speck of dust falls into it.

We can also observe how living organisms with new types of organisation arise during evolution. Twenty-five years ago the general outlook on evolution was still dominated by the Darwinian idea that evolutionary change depends on the selection of minute, continuously varying differences between the different representatives of a species. However, Bateson had already pointed out that there was considerable evidence that the steps in evolutionary advance are really more like sudden jumps, and the work which has gone on since then has tended to support this hypothesis. In the first place, we know that the way in which new hereditary characters arise is by a sudden change of a gene from one form into another different form, and although the effects of these two forms of the gene may be very similar or even overlap one another, it is clear that the underlying basis of hereditary variation is discontinuous. And secondly, we have discovered something of the importance of discontinuous changes affecting whole blocks of genes. In some cases, the whole gene complement of an organism becomes reduplicated, in others a whole chromosome or a part of one may be reduplicated, or a part of a chromosome containing a certain set of genes may be broken off from its normal place and attached to some other chromosome, or fixed back into its own chromosome with a reversed orientation. Alterations in the arrangement of the genes in this way can be obtained artificially, although they cannot be properly controlled as yet. The animals with these chromosome patterns behave to some extent as new species: they are often more or less infertile with their original parents. Most artificially obtained hybrids are infertile because the chromosomes derived from the two parents are not sufficiently alike to co-operate in the formation of viable germ-cells, but if, as sometimes happens, the whole chromosome complement of a hybrid becomes reduplicated, every chromosome gets an exactly similar partner and germ cell formation can proceed. In this way some completely new species have been made, and, in a few cases, already known species have been synthesised out of their original parents. Man has been able to carry out part of the evolutionary process experimentally: it is perhaps his greatest biological achievement.

In conclusion, let us summarise the system of concepts in terms of which modern biology states its knowledge about living things. At the basis of the conceptual system are the physical and chemical conceptions of atoms, molecules, electrons, etc. The biologist finds these entities arranged in units such as genes, whose properties cannot yet be reduced to the properties of the elementary entities as they are known in isolation.



A chicken embryo in which an extra head has been induced by means of a transplanted piece of "organisation centre." A. Head of host-embryo; B. Induced head.

(From Waddington's "How Animals Develop," by courtesy of Messrs. Allen & Unwin, Ltd.)

These units are themselves arranged to form still larger units: a species, from the evolutionary standpoint, can be represented as a definite arrangement of a group of genes, interacting with the environment. One phase of this interaction with the environment is the production of an adult body. The development of the body involves the interaction of the genes with the cytoplasm of the egg (the cytoplasm being at any rate partly under the control of the genes in the maternal organism) during which there arises a new order of arrangement of living material into organs with a definite structure. It is often possible to show how the function of the organ is made possible by its structure, but we still do not know how the structure is held together, except in so far as it has been shown that the pattern is dependent on an organisation centre.

An Imperial Botanical Conference, starting on Aug. 28 and lasting two to three days, will be held in London this year. The subjects for discussion include such topics as pasture research within the Empire, the ecology of tropical forests, problems of fruit storage and transport, the co-ordination of botanical research within the Empire, etc. The Chairman of the Organising Committee is Sir Arthur W. Hill, K.C.M.G., Director of the Royal Botanic Gardens, Kew, and the Hon. Secretary is Prof. W. Brown, Imperial College of Science, London, S.W.7.

Is Seeing Believing ?

By Professor D. F. Fraser-Harris, M.D., D.Sc., B.Sc. (Lond.), F.R.S.E.

In this article[1] on entoptic deceptions in the séance room, Professor Fraser-Harris reveals some of the imperfections of the human eye which often make it so untrustworthy a witness. In feeble light, and where the desire for visual evidence is strong, many moving objects can be " seen " ; but it is surprising how many of these are subjective.

As is well known, by far the greater number of séances are held either in total darkness or in a dull red light. The reasons for this do not at the moment concern us, but of course in some cases the dark has been insisted on to conceal the trickery and legerdemain of the fraudulent medium. But some genuine teledynamists (the name I give to " physical mediums " who produce telekinesis) aver that light, especially if it is rich in ultra-violet radiations, weakens or destroys their " power " so that they demand an illumination no more brilliant than that of a red lamp. It is, therefore, necessary that objects to be moved telekinetically in the dark should have self-luminous spots or bands painted on them. Originally this " luminous paint " contained phosphorus which glows in the dark but more recently a radio-active luminous paint has been used.

After having been for a short time in the dark or in a feeble light, the retina, physiologically at rest, becomes much more sensitive to light than a corresponding retina which has not been so rested (" light-adapted "). This increased sensitiveness of the retina is called Dark-Adaptation and chiefly concerns the periphery of the retina. It should be remembered that in the dark the pupil dilates progressively to a maximum.

Thus in the dark, since the dilated pupil will allow the maximal entrance of any light which may be present, and since the affectibility of the retina is rising rapidly, a source of light which is almost or quite invisible to a light-adapted eye, that is to one coming in from daylight, is quite obvious to a dark-adapted eye. The increase in sensitiveness is very rapid, for in the first two minutes it rises fifteen to twenty fold its initial value, and after twenty minutes it has almost attained its maximum.

All our past experience, and therefore visual memory, is of objects as they appear to the light-adapted eye, so that since a source of light which is physically feeble appears bright to the dark-adapted eye, it is judged in the dark to be much farther off than it really is. When to start with we know something of the distance of a particular light from us, then the brighter the light, the farther off we judge it to be. But in the absence of this knowledge, an isolated faint light is judged to be much farther away than it really is. In the absence of any known standard distance for comparison, judgment regarding the distance of a source of light is very liable to be incorrect.

The guiding light in the séance-room is never brilliant, but on the contrary always feeble, since it is produced by the " phosphorescence " of luminous paint. As this material, moreover, gives the impression of great indistinctness of outline, the result is that the physically faint and indistinct light is judged by the dark-adapted eye to be much farther off than it really is. Thus, Mr. Hereward Carrington says (*The Physical Phenomena of Spiritualism*, p. 166) : " I have myself known a guitar which was almost touching my head to appear to be several yards away."

Of course, if we can compare two lights simultaneously, we judge the more intense to be the nearer. Thus, when standing at one end of an underground station, we look into the tunnel and see the two signals side by side, one red, the other green, then the fainter

The paranormal displacement of a handkerchief actuated electrically the flashlight by which this photograph was taken. The red lamp (with conical shade) is at the level of the sitters' eyes. The medium (bending forward) is seen controlled by two persons in the National Laboratory of Psychical Research.

(By courtesy of Mr. Harry Price.)

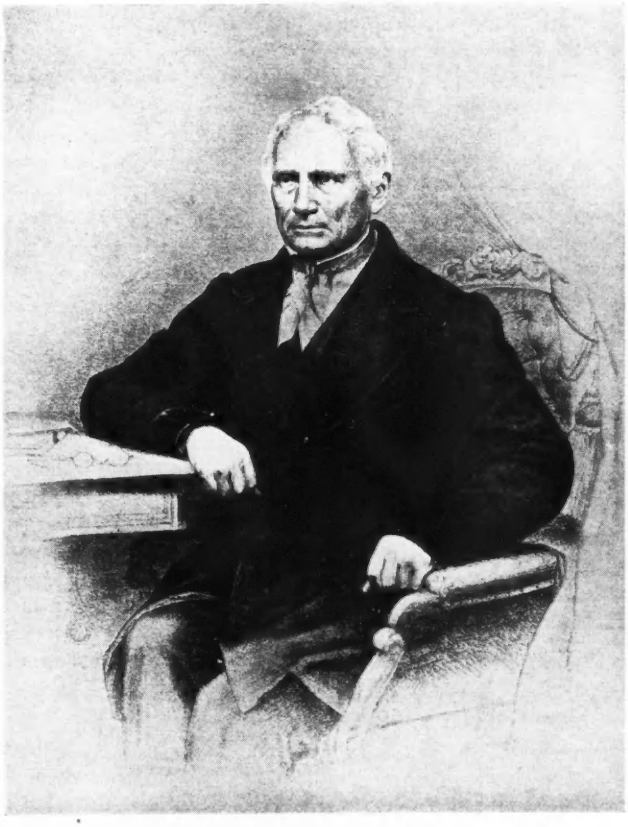
[1] The substance of a lecture given at the British College of Psychic Science, London, 1934.

green light is judged to be farther off than the brighter red one, for green has less intrinsic illuminating or retina-stimulating power than red even when the candle-power of the illuminant is the same in both cases. In the dark or in a badly lighted séance-room, since there is, in ordinary language, nothing to look at, there is no " fixation point " other than some spot of luminous paint at an unknown distance so that our perplexity regarding its distance, and therefore whether it may have moved or not since first observed, is considerable. Obviously, when a dull red light, the sole source of illumination, is, as is usual, *above* the level of one's eyes it cannot be available as a fixation point.

The next consideration is the phenomenon of the Intrinsic Light of the Retina. This is the correlate in consciousness of the variations in pressure, volume, or velocity of the blood in the retinal blood-vessels. The human retina, for its size, is extremely vascular, the object of this clearly being to provide plenty of blood at all times to carry off its waste-products and so prevent fatigue. In the dark, during sleep, in feeble light, or in a faint red light, the retina is in a predominant state of physiological rest (anabolism), as a functional result of which its sensitiveness to light becomes, as we have seen, greatly exalted (dark-adaptation).

Slight changes in the pressure, volume, or velocity of the blood in the retinal vessels acting as physiological stimuli and inducing correspondingly slight changes in the metabolic condition of the abnormally sensitive retina are interpreted in consciousness as the " intrinsic light of the retina." This takes the form of greyish or purplish clouds which seem to sweep almost continuously but with varying degrees of distinctness or intensity over the field of vision. Instead of luminous clouds, some people seem to perceive rivers of light, others a succession of scintillations resembling fireworks.

Unless one is in the habit of studying entoptic phenomena, the intrinsic light of the retina may never be observed at all, so that when it is experienced for the first time in the dark it may easily be mistaken for an indistinct light of external origin. It is therefore not difficult to understand how subjective sensations due to the intrinsic light of the retina may be mistaken for luminous clouds (" psychic lights ") in the external world.



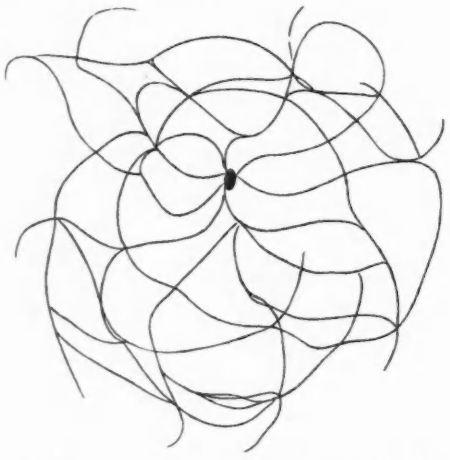
J. E. Purkinje (1787-1869)

We may now pass on to the Phosgenes or Phosphenes. By a phosphene we mean the perception of light when the retina is stimulated by mechanical pressure or by an electric current. The pressure-phosphene is by far the commoner. The electric phosphene can be observed when an electric current is made to pass through the eyeballs. One electrode may be placed over an eyelid, the other being on some part of the skull, or the current may be sent across both eyeballs from one side of the head to the other. On closing and opening the current, most observers report an entoptic flash of yellowish light " like summer lightning." (Doubtless " the blinding flash " of light experienced by persons struck by lightning is the electric phosphene).

The normal (homologous) stimulus for the retina is light, but pressure can be a stimulus (heterologous) as when we press on the eyeball and see inside the head large spots of light, the phosphenes. (This is an example of Johannes Müller's " Law of specific nerve energy. ") The principle of outward reference is applicable here, for when we press on the outer side of the eye, the light seems to be inside the nose, and when we press on the

inner side of the eye, the light seems to be somewhere out in the cheek. The extreme and most familiar case of phosphenes is, of course, that of the " stars " which a prize-fighter sees in consequence of a blow on the eye. His retina has been subjected to so violent a mechanical stimulation that he experiences a gorgeous display of scintillating phosphenes (" stars "). Now after long residence in the dark, the retina becomes so sensitive (dark-adapted) that even the relatively feeble pressures caused by the winking movements of the eyelids over the eyeballs may give rise to phosphenes. For in order to see more clearly in a bad light, we instinctively keep on blinking and peering so that the recurring slight pressures by the eyelids are, when summated, capable of evoking phosphenes. These subjective apparently floating lights may easily be mistaken for lights of objective origin (" psychic lights "). In any case even the most experienced observer in the dark should bear in mind the liability to perceive these faint phosphenes as the result of the repeated blinking movements of his eyelids.

The next entoptic possibility we ought to think of is the occurrence of " Purkinje's Figures." These so-called " figures " are due to the perception of the shadows of



An enlarged representation of " Purkinje's figures," the shadow of the retinal blood-vessels described by the Czech physiologist, J. E. Purkinje.

the retinal blood-vessels thrown on the sensitive layer of the rods and cones by light which happens to enter the eye at one side of the lens instead of, as normally, through its substance. There is thus no true focussed image, it is the *shadow* of the vessels that is cast on the sensitive layer. The numerous retinal vessels are highly anastomotic, and their shadows resemble nothing so much as the branching cluster of a piece of red seaweed which when dried and flattened used to be a familiar object in lamp-shades in Victorian drawing-rooms. The piece of seaweed was mounted as a semi-transparency in the lamp-shade, and when the light shone through this circular patch of branching seaweed we had a good imitation of " Purkinje's figures." In favourable circumstances, the circulating blood itself and even one's blood-corpuscles can be perceived.

It would be possible to perceive Purkinje's figures in the following circumstances : if the retina has been some time in the dark and therefore has become very sensitive, and a light is suddenly turned on well to one side of the head so that a comparatively powerful beam enters the eye behind the lens, then the shadow (not the focused image) of the network of retinal vessels would suddenly be cast upon the dark-adapted retina with the result that one might perceive a richly branching figure, in which even the moving blood might be seen. The figure is, of course, mentally projected outwards through the lens by the " Law of Outward Reference," so that if, say, the left region of the left retina has been stimulated, we should imagine the source of the illumination to be somewhere to the right of the situation of the entering light, for in our past experience the left side of the left retina has received rays from objects in the right region of the visual field. There is little doubt that some " ghosts " have been nothing more than the outward projection of the subjective sensations produced by Purkinje's figures, for in the absence of information to the contrary, we instinctively assign a source in the external world to every visual phenomenon.

Another source of observational error may be the possible presence of *muscæ volitantes* or " flying flies." These are the shadows of cells or chains of cells[2] in the vitreous humor thrown on the sensitive retina. As these *muscæ* lie behind the lens, they are not focussed by light passing through the lens, so that only their *shadows* are cast on the rods and cones. No doubt *muscæ* are not to be seen in the dark ; but if we have a dark-adapted retina suddenly exposed to light after a long time in the dark, then through the widely dilated pupil enough light may enter the eye to produce the vision of the *muscæ volitantes* which, in less sensitive conditions, would not have occurred. The eye is now capable of responding to these feeble entoptic stimulations. It is not improbable that the source of some accounts of " moving objects," " psychic lights," may have been the *muscæ*.

Further, the possibility of after-images should always be borne in mind. Doubtless a feeble illumination is not

[2]According to Prof. Hartridge, F.R.S., these bodies are not cells but vestigial remains of the connective tissue of the embryonic hyaloid artery.

the best for the development of these subjective sensations, nevertheless workers whose observations are almost exclusively visual should be prepared to experience after-images more particularly of the " negative " order. The typical phenomena referred to are : after staring for a time at a white surface, its black after-image is seen ; if we have gazed at a black surface, a white is seen ; while after red, a green colour, and after yellow, a blue is experienced. As I have shown (*Jour. Med. Psych.* XII, ii, Oct., 1932), the formation of after-images may explain the " auras " described by occultists around human beings and other solid and even inanimate objects. It would be possible after staring at the red light, for instance, to obtain a green after-image which, before it faded, would vitiate any subsequent visual impression.

We should always remember the difficulty of pronouncing on the movements of feebly illuminated objects in the dark. At those dark séances where the purpose is to observe the movement of objects (levitation or telekinesis) one has to stare steadily and for long periods at spots or bands of luminous paint. Often these are the only sources of light. Sooner or later the questions arise : " Has the object moved ? " ; " Is it now moving ? " ; " Is it oscillating ? " To answer these with complete certainty is often very difficult or even impossible. In the first place it is notoriously difficult to judge of the motion of a body in the line of sight. Within the dimensions of the séance-room, the alteration in size of the spot or band in motion is so very small that no information about its movement can be derived from this source alone. When the object traverses the field of vision, this difficulty is less serious, but even when the luminous spot is traversing what is after all a small field of vision, one's time of observation of it may be very short indeed. Further, there is the ever-present complication arising from the absence of other visible objects to indicate relative distance. In other words, although as a matter of fact our vision in the dark as in the light is binocular, we are deprived of the advantages of binocular or stereoscopic vision by the total absence from the visual field of the factor of *depth*.

Imagined Movement.

And there is another complication : when we have been staring with both eyes, as we think, steadily at a single object, the two eyes, under the control of their antagonistic pairs of muscles, are in reality oscillating very slightly in the horizontal plane. The result of this staring at a small, not very bright white spot or band against a black background is to produce an after-image of the white spot (or band) which on outward projection will appear to be oscillating slightly. Thus we may easily imagine that a stationary spot is in slight movement. Finally we have the possibility of the difference between two views of an object giving rise to illusion of movement.

Monocular Vision.

Where astigmatism exists, owing, let us say, to the kind of astigmatism in one eye being noticeably different from that in the other, it is possible to get a view of an object in one eye which is not identical with that in the other. The result of this may be that if we have been watching an object with one eye and have judged it to be of a particular size and outline, and then have looked at it with the other and noticed a difference, we might be led to conclude that the object had moved in the interval between the two observations. No doubt true monocular vision in the séance-room is not common : but what amounts to monocular vision can occur when we are occupied with something in front of us (as in controlling a medium) and are watching from time to time an object at some considerable distance to the right or left in the field of vision.

Pitfalls of the Séance-Room.

The entoptic complications arising out of the conditions usually prevailing in the séance-room may, then, be summarised as under :—

1. Owing to insufficient illumination at dark séances, illusions of various kinds are liable to be engendered.

2. After a comparatively short time (twenty minutes) in the dark or in feeble monochromatic illumination, the sensitiveness of the retina is greatly increased so that, we are apt to overestimate the distance from us of any feebly luminous object.

3. We should bear in mind the subjective impressions due to the " intrinsic " or " specific " light of the retina. There is no doubt that these have occasionally been the source of " mists," " purple clouds," " psychic lights," or " ghosts."

4. The possibility of experiencing pressure-phosphenes from the summation of the stimulations of the retina by the repeated pressures of the eyelids in blinking and peering should be reckoned with.

5. Given certain conditions—a highly sensitive retina and the sudden appearance of a light well to the side of the eye—a " Purkinje figure " might be produced and mistaken for an external object or " ghost."

6. The possibility of after-images especially of the reversed or negative kind should always be remembered.

7. There is great difficulty in pronouncing with certainty in a dark room whether a small object has or has not moved, particularly if it is in the line of sight.

Drilling for Water.—II.

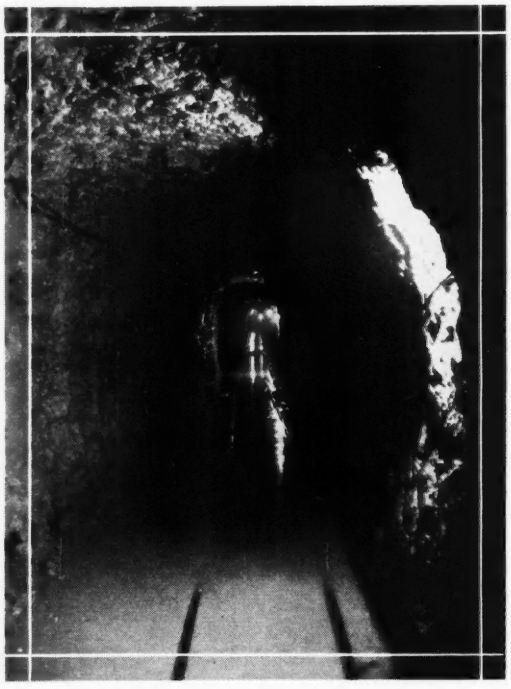
By Leonard. A. Iggulden.

In the first part of this article, which appeared in our April issue, the general principles of artesian wells and the usual drilling methods were dealt with. The devices for meeting an ever-increasing demand for water are now discussed, and the mechanism for the actual delivery of the goods—an unimagined romance of everyday engineering.

Having considered in some detail the two best known drilling systems, we may now turn to other matters of interest in connection with underground supplies. So important is it that the chalk should be preserved as a source of water supply to hundreds of city offices, factories, institutions, etc., that, in consequence of the falling water level, it has been suggested by engineers who have studied the matter in some detail, that it might be possible, though probably at enormous cost, to construct feed-wells at selected points, chiefly along the outcrops of the chalk. Water is being drawn from the London Basin at a rate that is greater than the replenishment, and one remedy certainly would be to collect in suitable impounding reservoirs much of the annual flood water, and, after proper filtration, to feed the water into the chalk. Many millions of gallons daily would have to be dealt with, and the cost, particularly of the construction of suitable shafts, galleries, and headings, would be tremendous, and would doubtless have to be borne by the State; this would almost certainly mean that the days of uncontrolled well-sinking would be over, at any rate as far as London is concerned.

The direction of flood water into the London Basin raises many interesting points, and space will not permit a lengthy discourse. In view of the fact that the water which is at present pumped from the many deep wells in London and greater London is invariably of a high degree of purity, the problem would need careful consideration by a committee of experts. Should such a proposition eventually become a reality it might easily mean the raising of the water levels to something like the old levels of 100 years ago. It is interesting to note that in many cases, although the water level has fallen, the supplies have been well maintained, and 5,000 to 12,000 gallons per hour are common in different parts of London.

Many industrial concerns need hundreds of thousands of gallons per day, and many ingenious devices are adopted to produce really large supplies. The photograph here was obtained during the construction of what may be termed a "water mine, situated in north-west London. A large shaft, 6 to 8 feet in diameter, had been sunk to 300 feet below the surface; from the bottom a heading 6 feet high by 4 feet wide was driven horizontally for over a quarter of a mile through solid chalk. The writer was taken down this water mine during the course of construction, and the experience was like being in a rather heavy rainstorm—water percolating and oozing in from the roof and walls on to the floor of the heading, from which pumps conveyed surplus water to the surface. This heading was driven in the direction of, and eventually connected up to, another borehole, and when the second well was pierced by the tunnel, water was to be seen bubbling up to the floor of the heading from greater depths. The photograph gives an excellent idea of the underground conditions. These water mines are becoming increasingly popular, and it is not uncommon to find large industrial concerns with sometimes as many as a dozen deep boreholes, interconnected by headings, and producing supplies of excellent water running into millions of gallons per day.



A "water mine," an underground gallery connecting two deep boreholes.

Highly successful experiments have been made on

several occasions during recent years in attempts to produce greater supplies from existing borings, by means of what are termed deflected borings: that is, branch boreholes, usually of smaller diameter than the main bore, drilled at selected points. From a consultation of a log of any particular boring it is usually possible to ascertain the zones in which the greater quantities of water are to be obtained. A special tool and deflecting apparatus (details and illustrations of which are not available) are lowered in the borehole to a point above the selected water zone, and with care it is possible to drill at an angle of about 30 degrees. Deflections are usually carried about 50 feet, and greatly increased supplies have been obtained, particularly from the chalk formation. The operation calls for exceptional skill in drilling. One large water company in England relies almost entirely upon several boreholes, each with two or three deflections, for its supply. The deflections, made some time after the boreholes had been completed, resulted in an increased supply of nearly 100%.

As has been previously stated, unless an overflowing supply is obtained from any given well, some form of pumping apparatus must be installed to elevate the water from its static level to the surface and thence to the storage tanks, frequently 30 to 40 feet above the surface. Many different types may now be had, but the particular type to be selected depends on many different circumstances which need not be gone into here. The various types may be summarised as follows:

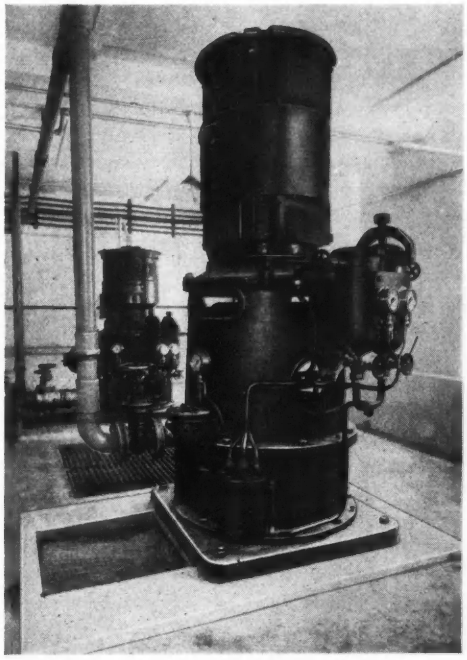
(*a*) Reciprocating Plunger Pump
(*b*) Air Lift Pump
(*c*) Vertical Spindle Pump
(*d*) Underwater Motor Pump

(*a*) This is one of the oldest types of well pump, and one which, while somewhat antiquated when compared with more modern types, has still much to commend it. Instances have been known of this type of pump working for over thirty years without being overhauled.

(*b*) This also is a very old type of pump, and has the advantage of having no working parts below the surface. The only parts that can possibly go wrong are all on the surface, hence the great ease with which breakdowns may be dealt with.

(*c*) A very popular type of pump, which has now become very well known. Very large quantities of water may be raised from fairly small boreholes at very economical figures. These pumps are admirably suited for raising water to any reasonable height above the surface, and are noted for the small amount of space they require.

(*d*) The Underwater Pump is quite new in this country, but an electrically operated pump has now been successfully produced, and several are operating in a highly satisfactory manner in this country. The pump is of the turbine variety, and is actuated by an electric motor situated at the bottom of the rising main. The motor actually operates in the water, and there are no working parts on the surface apart from the starting panel.



Borehole pumps of centrifugal type, each yielding over 10,000 gallons per hour from 300 feet below the surface.

Certainly the deep borehole has come into its own during the last thirty years or so, and when the whole matter is considered, it cannot be denied that in a vast number of instances, the installation of one or more deep wells has been the means of supplying many millions of gallons of good water, and relieving the water companies during difficult periods of the year.

Space will not permit a more detailed reference to the qualities and characteristics of underground waters, but it is hoped that sufficient has been said to show that the subject is a very large one, and calls for the careful attention of all executives who are striving for economy, efficiency, and progress in modern industrial life.

Electrical Treatment of Bees.

By V. Sinclair.

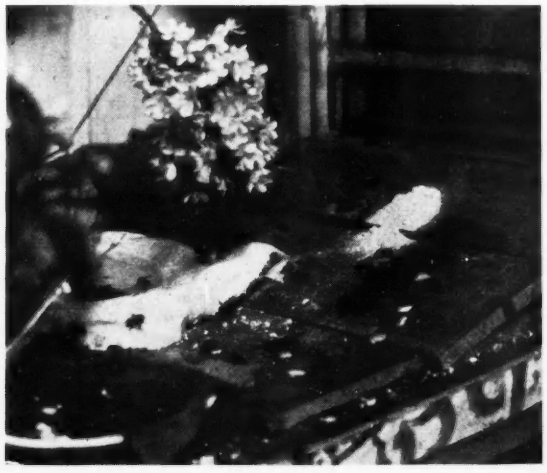
Bees, like humans, find the English spring somewhat trying. Recent practice has shown that they respond admirably to artificial warmth and sunshine. Mr. Sinclair gives some interesting details on the application of this treatment.

A NEW use for electricity has recently been developed, by which the bee-keeper stands to benefit in several respects. The pioneers of this application, starting from the recognition that natural functions are frequently handicapped by climatic and geographical conditions, and being aware of the fact that our early spring weather is very fickle, concluded that if fowls could be induced to lay more eggs by giving them an artificially lengthened day, bees would probably be more efficient if adequate compensation were provided for an elusive ideal spring. In this connection it should be borne in mind that many of the bees kept in this country are Italian hybrids and are therefore accustomed to more favourable spring weather than is often experienced in these islands.

Experiments were therefore made with the object in view that bees, on awakening from their winter torpidity and resuming their spring activity, should find themselves for some time in artificially created ideal spring conditions, and not be subjected to the weakening due to cold winds and night frosts. Our climate is particularly erratic in these respects just before the time when the apple blossom is at its best ; then, if broods have been chilled and debilitated beforehand by bad weather, not only are they too weak to fly far afield and to make the best of that source of honey, but the apple trees do not get the amount of pollination that is necessary to ensure a good crop of fruit. As a result of the experiments, practical methods have been established, which are within the reach of every bee-keeper for a small outlay wherever electricity is available, the actual quantity consumed being an almost negligible factor. The principal benefits which accrue are strong hives which are less subject to bee diseases, an earlier and increased yield of honey and, as stated, better pollination of the apple orchard with larger crops.

The principle employed is to make an outlet at the back of each hive and to bring up against this a special fitting, lighted and heated electrically, where the bees can feed and take exercise irrespective of the weather and earlier in the season than normally. The principle may be applied in either one of two ways : in the one, the fitting takes the form of a special enclosure, covered in with glass and containing the necessary deceptions ; in the other, the hives that are to be treated electrically are housed under a common roof and the fitting consists of a table on which the stage is prepared. Where a suitable house is available the advantages of the latter method are that the outlay on fittings is much less and the hives can be attended to in any weather without risk of chilling the broods. We shall therefore confine our remarks to this method, on which some of the principal pioneer work has been, and is being, carried out by Mr. R. Borlase Matthews on his all-electric farm at Greater Felcourt, East Grinstead, Sussex.

Here, from eight to ten hives have been housed under a common roof, the building being provided with openings in the outer walls for the bees to reach the open air



The electrically-heated treatment table at the back of the hive, showing worker bees feeding on sugar syrup and artificial pollen.

when the treatment has been completed and the weather is settled. The bee-house is, of course, lighted and heated electrically, the temperature being automatically maintained at about 60°F. by means of a thermostatic device. At the appropriate time a table is brought up against the back of each hive and is closed off by means of a glazed door. The equipment on the table and in the chamber thus formed consists, firstly, of a special reflector, of a shape arrived at by experiment, containing a 60-watt electric lamp and closed with a thick disc of glass. The object of the latter is to prevent the bees which cluster in front of the lamp from getting burnt. The reflector is tilted at such an angle as to throw the

light into the back outlet of the hive. This represents the artificial sun. The further deceptions consist of early flowering plants such as cherry blossom and palm, which are placed in water, changed daily, and provide a little natural pollen; a dish of loaf sugar syrup containing vinegar and salt to stimulate the production of brood-honey; a saucer of pure water; and last, but not least, another saucer containing artificial pollen. A thermometer is hung on the wall over the table, and a small electric heater is placed under the table.

When the hive becomes aware of the light shining through the rear opening, the working bees are attracted out on to the table, where they are deceived by the artificially arranged natural conditions into taking exercise and feeding in warmth and light. Simultaneously, the queen bee begins to lay her eggs at a time when, if the hive were in the open, she would not do so. The result is that by the time the apple blossom is at its optimum a strong hive is forthcoming, capable of emerging and of taking full advantage of this source of food when other hives in the same neighbourhood are not strong enough to do likewise.

Records taken at Greater Felcourt have established the fact that hives treated in this manner yield on the average about 17 to 18 lbs. more honey per annum. This, in itself, might not be considered sufficient inducement to adopt the treatment, but when the benefits as a whole are taken into consideration over a period of time, it has been found that the treatment is worth while and pays for itself. Apart from the fact that it does not involve overworking the bees or their productive organs, but merely rectifies climatic irregularities, it must be obvious that a strong hive is an asset which is less subject to disease.

To give a concrete instance, the last winter but one many bees in the East Grinstead district died of dysentery, while those in the electrically heated hives escaped. The cause of the disease was the muggy weather, which produced a mould in the hives. The bees, being such clean insects, ate the mould to "char up" the hives, and this gave them dysentery. Examination showed that the electrically heated hives were free from mould and thus the bees in these survived.

The Triumph of Steam.

No. 2750 "Papyrus," the L.N.E.R. locomotive which hauled a train weighing 213 tons from Newcastle to London (King's Cross), 268 miles, in 3 hrs. 50 min., reaching a maximum speed of 108 m.p.h. This locomotive is of standard type; it will be interesting to see whether its record can be beaten by the streamlined G.W.R. locomotive now in construction.

Amazon Calling.

By Lieut.-Colonel Arthur J. Woodroffe.

Late Royal Engineers.

In these days of wireless wonders it is worth while to give a thought to the pioneers of progress in the use of radio waves. Col. Woodroffe's ingenious methods in forest " navigation " are of the highest interest and his article comes appropriately in this month's survey of scientific progress. The photographs appear by courtesy of the Royal Geographical Society.

It is difficult in these days of portable sets and perfect reception to realise that radio some twenty years ago was just the unromantic dot and dash of morse. Yet so it was, and the hour of the jazz-band and the crooner was still to come. For all that, there were people intensely interested in radio performance, lacking though it was in entertainment value.

Let me explain. At this time arrangements had been completed to delimit the international boundary between Peru and Brazil, in a land of rivers and dense forest. When a boundary of this kind is to be delimited, the governments concerned draw up a protocol agreeing to a provisional line, which then has to be surveyed. In the absence of natural features, boundary marks have to be erected. The work is carried out by parties representing their respective governments, and is compared at intervals as the work progresses. The greatest accuracy possible, consistent with a certain maximum expenditure of time and money, is required.

Since triangulation, the best of all methods, is impossible in a forest, one must have recourse to traversing, or astronomy of position, or a combination of the two. In

A typical river scene on the Upper Amazon.

practice the last named is the usual procedure, and consists of traversing controlled by points astronomically fixed. Photography from the air, controlled by astronomical points, was not possible in those days.

As all ocean travellers are aware, the winner of the pool on the day's run is announced shortly after " taking sights," in other words when the position of the ship is known. The principles of forest navigation are the same, and even in the forest "pools on the run" can generally be found. But while an error of a mile at sea is admissible, since this distance is easily seen, it is quite another matter in the case of a boundary survey. Much greater precision is obviously required, so stars are used instead of the sun, and there are various refinements in respect of instruments and methods, so as to get the most accurate results from this " positional " navigation.

A Battery of Chronometers.

The latitude of a place has never presented any difficulty. With an approximate knowledge of the local time it can be found. But since the difference of longitude between two places is the difference of time between them, it is necessary to know the exact time at the first place at some given moment, to compare it with the local time of the second. The first place is often called the base, and its longitude is generally known. In the old days a battery of chronometers was usually carried, and the time was thus literally transported from one station to another, due allowance being made for the estimated travelling rates of the chronometers. But while a fairly reliable result can be obtained from two or three chronometers at sea, carrying them through the rough and tumble of a survey in wild country is quite another matter. One was never sure of the result.

Then came radio, and the problem of longitude was solved. For since the time of transmission is negligible, the actual chronometer beats could be signalled by radio, and listened to at the distant station for comparison. The exact errors on local time of each chronometer are of course allowed for. There was no radio telephone then, so the pendulum of the base chronometer was connected to the circuit and sent out signals. One simple method was to fix a small needle on the end of the pendulum ; its point passed through a blob of mercury placed at the lowest point of the swing, making a momentary electrical connection in this way. Nowadays this complication is not necessary, since the actual beats of the chronometer can be heard in the loud speaker: Arrangements are made to announce the coming minute,

Forest conditions prevalent on the Peruvian frontier. On the left, a view of a cutting in " good " forest country ; on the right, preparing a cutting through bad bamboo undergrowth.

and the 58th and 59th beats can be suppressed as a check on the minutes during the comparison.

There is a simple and very pretty method for the actual comparison of the beats. If the chronometers at the sending and receiving station were both keeping the same kind of time, the interval between their beats, to the ear of the observer, would remain constant, and the elapsed fraction of a second would have to be estimated by him. But let us suppose that the base chronometer, beating seconds, keeps mean time, and that at the receiving station sidereal. The latter gains one beat on the former in about six minutes, which means that every six minutes at some point there is complete coincidence of sound, then the beats gradually separate to their maximum difference (half second), after which they come together again to complete coincidence. All that the observer has to do is to note the times when the beats appear to him as one, a fact that the ear appreciates with great accuracy. In effect this is a vernier time-scale of sound which should give a precision in the neighbourhood of 1/100 second.

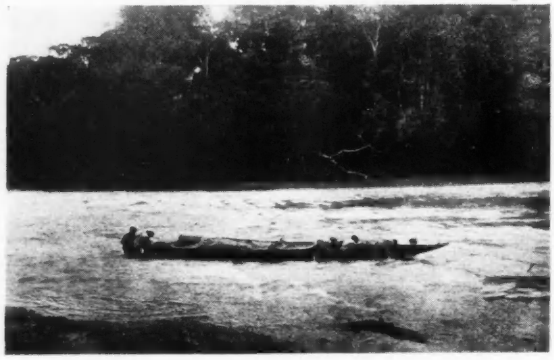
The Peruvian Government, which I had the honour of representing, spared no expense to ensure the success of the expedition. 60° prismatic astrolabes, geodetic model, were used for the star observations, beautiful instruments, weighing 70 lbs., about which pages could be written. It was possible to obtain with them a precision comparable with that of fixed observatory instruments. To give some idea of their accuracy in skilled hands, an error of about 12 yards in any direction might be expected. Unfortunately, in astronomical observations there is always some uncertainty about the effects of " local attraction " of gravity, a phenomenon too complicated to discuss here, which may vitiate such an excellent result. This cannot, however, be avoided. In the matter of radio outfit we had the latest " portable" receiving sets. They would raise a smile nowadays—cumbersome boxes filled with weird and complicated devices, and wires for an aerial about 100 yards in length.

A more ambitious scheme for *sending* over short distances involved the supplying of power by a man working a kind of bicycle provided with a dynamo. It had to be abandoned when it was found that even a strong man was completely exhausted after a minute or so !

The position of Parà, at the mouth of the Amazon, was known and this was our first base. A cable on the bed of the river between Parà and Manáos was utilised to exchange time signals to fix the relative position of the latter point on the Rio Negro just above its junction with the Amazon about 1,000 miles from the sea. The field party went on by launch from Manáos about 800 miles up the Rio Purus to Senna Madureira where there was a wireless station. Radio signals were exchanged between Manáos and Senna, to fix the latter point. Both these

stations were operated on the Telefunken system with long wave and musical note. The Manáos station was alongside a swamp, a little way from the town. The mosquitoes there are well named "zancudos de vaca" (cow mosquitoes). I have painful recollections of their attentions while trying to concentrate on star contacts. Two pairs of flannels were insufficient to prevent their drawing blood.

In due course the second party arrived at Senna, of which the position was now known. We had thus covered 1,800 miles in two "hops" of longitude to get to the scene of operations. From this new base the "portables" came into full play, and the real work began. It was necessary to stretch the aerial between the tops of trees, and a tree-climbing expert was specially engaged for this work. He drew a good salary, and was an excellent climber, but he had his own ideas as to the suitability of trees, irrespective of their radio value. To get best results it was necessary, for carrying the aerial, to select two trees more or less in alignment with the sending station. It was quite a common occurrence, after two excellent trees had been chosen, for our expert after a single glance upward to refuse emphatically to climb. He was a good judge, for the objectionable tree was usually infested with a certain kind of small ant, of which the bites not only fester for days, but also produce a low fever. On one such occasion no ants were visible. Another man standing by volunteered to climb. He had not made much progress when it became obvious that things were not going well, and he started to come down again so fast that it looked as though he were going to finish the return journey by air. He arrived at the ground in a terrible state, bitten all over. After that the expert's assurance about ants was accepted.



Hauling the canoe up shallow rapids.

Once the aerial was in position, the signals generally came through very distinctly, though the atmospherics were occasionally bad—almost like the rolling of distant drums at times—when, if it had not been for the distinguishing musical note of the Telefunken, work would have been impossible. It is interesting to note that, even in those days when stations were few and far between, we suffered at times, due to interference from a Telefunken station on the hill of San Cristóbal at Lima, on the Pacific coast.

On leaving Senna, navigation by launch was no longer possible, and canoes had to be used for going up the Rio Santa Rosa, a tributary of the Purus. As a rule they had to be poled, punt fashion. In the shallows everyone would have to get out and push. Here the danger in the water-holes was a small fish called piranha, about the size of a man's finger, but with teeth like serrated razor blades. Once a member of the expedition, a carpenter, removed his trousers to wade through the water. Two of these fish leaped simultaneously at him out of the river, removing gobbets of flesh from a tender portion. Thereafter, the entire party remained trousered whatever happened. Besides the piranha, boa constrictors lie in the pools on the upper Amazon, making it dangerous to take that tempting plunge after the day's work. Canvas baths, though they do not sound heroic, are the things to use thereabouts.

Other interesting inhabitants of these regions are grasshoppers that seem to spend their entire existence in volplaning from high branches to lower ones; caterpillars that, in the evening, when poked with a stick, light up all their "compartments" like an electric train; butterflies, covered with an exquisitely tinted floss that leaves a poisonous rash on anyone handling them; centipedes with innumerable legs and a head that will bite a man long after it has been cut off; scorpions that commit suicide with their own tails when surrounded with a ring of fire; vampire bats that fan the sleeping victim with their wings whilst they suck his blood; snakes, lizards, chameleons, sand-flies, leeches, ants.

Even variety can pall, however, and there were times when one sighed regretfully for the peaceful backwaters of the Thames. Rise at daybreak; breakfast. Then the long day in the canoe. Clear site for camp; dinner. Star work and wireless signals. Turn in. So the days went by.

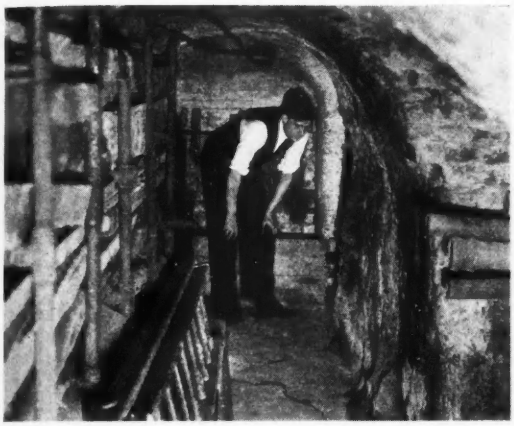
* * * *

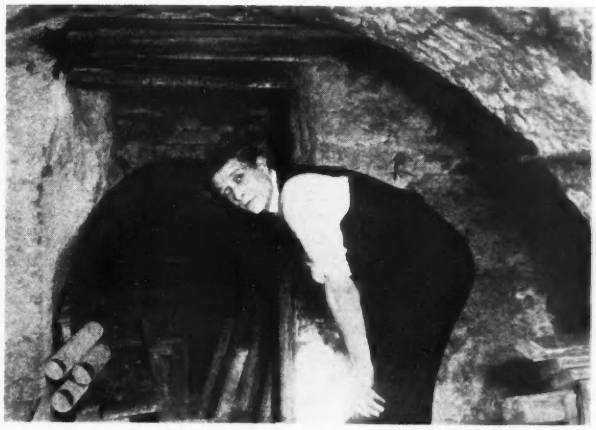
Something seemed to have gone wrong with the works at Senna Madureira. Then one night, after a week's silence, they were on the air again. After the usual time signals, some message began to come through. Not a long one. The operator came running over with a slip. "Look, señor! Something that shall be interesting, I figure." He had figured correctly! The message was "*Great Britain declares War on Germany.*" The date was August 5th, 1914.

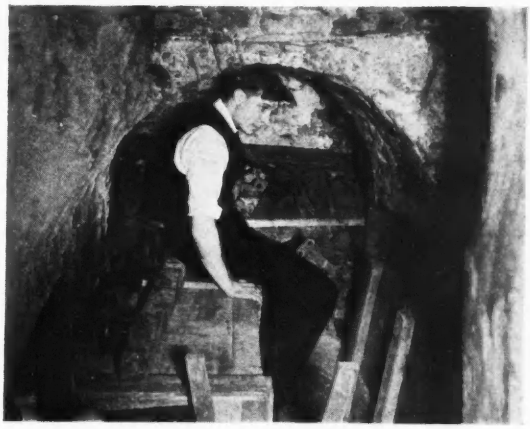
A Link with Old St. Paul's.

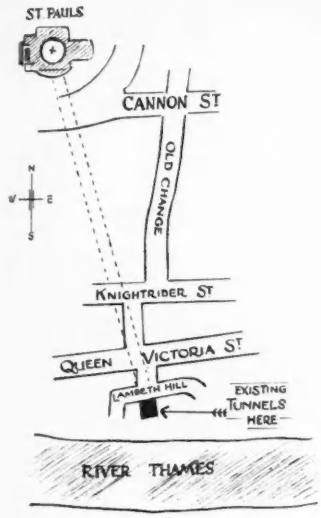
By A. Ronald Traube.

London's cathedral is very much "in the news" this month. The present article would suggest that its precincts were once used for purposes very different from the Jubilee Thanksgiving Service of May 6th. It is hoped that a report of further excavations will shortly be forthcoming.









Three views of the Lambeth Hill tunnels. Top left, the main passage; top right, the entry of a cross tunnel, leading out of the main passage; right, the bricked up end of a cross tunnel. The plan shows the suggested route of the tunnel, indicated by the dotted lines.

In a double basement in an old building in Lambeth Hill, Queen Victoria Street, occupied by a firm of boiler engineers, lies a section of a secret passage that is probably undisturbed from the time when it apparently formed part of an underground passage from old St. Paul's to the river. That this is more than just a possibility is borne out by the position as shown on the diagram, which is almost in the most direct line between the cathedral and the river. From the engineers' workshop in the upper basement one descends an iron ladder into the second basement, now used as a store, which is nothing more than a long, low passage intersected by two others. They are barely four feet wide and about as high, and apart from additional supports added to take the weight of the workshop above are the same as when they were built, although the ends have been bricked up.

What secrets lie behind these closed walls? In order to find out, the present owner intends opening up one of them provided he can obtain the sanction of owners of adjoining property.

Book Reviews.

An Introduction to Atomic Physics. By JOHN THOMSON. (Methuen. 10s. 6d.)

In his absorbing *Experiment in Autobiography* Mr. H. G. Wells writes of his student days at the Normal College of Science and never more vividly than when describing the shock to him of the break in the process of interest, when he turned from biology in the masterly grasp of Huxley to physics in the dull fumbling fingers of Guthrie. The contrast was acute, and revolt ensued as he realised that Guthrie would never take him where he might feel he was near " the real living edge of the subject, the line of open questions on the verge of the unknown." But generously, and with maturer insight, he now sees that " beyond the empirical practical truths of the conservation of energy, the indestructibility of matter and so forth, hung an enigmatical fog." Since 1886, much fog-laden ground has been cautiously and patiently explored, and to-day we can be taken, as we are by Dr. Thomson, to that " real living edge " whence the physicist and mathematician grope together towards the ultimate nature of matter and radiation.

Dr. Thomson states that his immediate aim in writing his *Introduction to Atomic Physics* is to provide a logical account of the fundamental facts and theories of the subject. He hopes that the reader may thereby gain a " clear idea of the essential simplicity of atomic phenomena." (A little startling, this last, but perhaps Dr. Thomson only means to be encouraging.) The work is planned in three parts. The first traverses the experimental basis of the modern theories of atomic physics, the second presents the new views of the nature of the atomic structure, and the last deals with the interpretation of atomic, molecular, and nuclear radiation.

Part I contains a brief, but for the author's purpose sufficiently adequate, survey of the experimental work which led to the conception of electricity as atomic in nature, and to the isolation and identification of the electron. An account is then given of the view of the atom as a compact of electrons, protons, and neutrons, and the importance of the " atomic number " of an element made clear. The section concludes with an introduction to the theory of quanta and an outline of Bohr's theory of spectra.

Part II opens with a critical study of Bohr's picture of the atom, the shortcomings of which are clearly indicated. The newer lines of approach to the problem of atomic constitution devised by Heisenberg and by Schrödinger with de Broglie, are then considered though the wave mechanics of the latter only is developed in detail. (Here the good mathematical equipment which the author explicitly assumes the reader to possess will be required if he is to survive the argument.)

A visual picture certainly emerges more readily from the wave method of Schrödinger than from the matrix method of Heisenberg, and instinctively therefore the physicist inclines towards it—though Eddington epigrammatically ascribes its popularity to the fact that it is the only one simple enough to be misunderstood. The interesting section which follows on the experimental verification of de Broglie's theory of the wave nature of particles might perhaps have been amplified to advantage.

In Part III Dr. Thomson considers the new developments in the theory of line spectra, extending the treatment in Part II, and reveals the great advances made by the applications of the quantum theory in accounting for the spectra of the more complex atoms. The work concludes with a review of the facts of radioactivity, the treatment of X-ray transformations by wave mechanics being particularly clear.

To sum up, the book will certainly appeal to the more advanced and mathematically relatively well-equipped student as a competent statement, though the layman will read it with but scant profit. As Mr. Wells puts it, " the gap has still to be bridged between the ideology and phraseology of normal intelligent people and that of the specialists." It grows daily more improbable that the gap will ever be bridged. Those who would share with the specialist even his faint glimpses of the promised land where truth abides must first be prepared to submit to a discipline growing ever more rigorous. But a pathetic belief in the ultimate simplicity of the Creator's plan lingers on.

Primitive Land Plants, also known as the Archegoniatæ. By PROFESSOR BOWER, Sc.D., LL.D., F.R.S. (Macmillan, 30s.)

Professor Bower has consistently and with conspicuous success devoted the greater part of his life to problems relating to the architectural construction, the anatomy, life-histories, and relationships of plants occupying a middle position in the vegetable kingdom, between the lowest class and the seed-bearing plants. His own researches extending over fifty years are mainly concerned with the Ferns and their allies, and he has also published several books, the most important of which are valuable contributions by a recognised authority to the comparative morphology and phylogeny of the Archegoniatæ. His book on " The Origin of a Land Flora, a theory based upon the facts of Alternation " was published in 1908; this was followed by three volumes on the Ferns (1923-1928) and in 1930 by a volume on " Size and Form in Plants." Now we have a book in which the author's views are restated and supplemented in the light of recent additions to knowledge in that section of botanical science of which he has an unrivalled acquaintance. It is a learned treatise, a corpus of facts with a critical analysis of their implications as evidence of relationships and of the course of evolution. The book will be welcomed by his colleagues as the latest presentation of opinion on debatable and in part insoluble problems; it will appeal to advanced students whose interests are morphological and who are attracted by academic discussion. One wishes that the author had seen fit to give a more concise and connected judicial summary of his views without a repetition of the embarrassing wealth of descriptions that have been previously published.

As in the earlier book of 1908 the author pays special attention to alternation of generations in the Bryophyta and Pteridophyta, and it is noteworthy that he adheres to his previous opinion on the origin of the spore-bearing phase in the life-cycle, a phase which he regards as having been interpolated as a response to conditions imposed by a transference of plants from an aquatic to a terrestrial environment. This conception of the sporophyte, known as the antithetic theory of alternation, implies a more recent origin of the spore-bearing generation than the sexual generation; it is not by any means universally accepted. Among the contributions to knowledge since 1908 the exceptionally important discoveries of early Devonian land plants must be given the highest place, and Professor Bower deals fully with the evidence afforded by these oldest known members of a land

flora. The chapters on the Psilophytales and Psilotales are particularly interesting and suggestive.

Part I (Chapters i-xxiii) consists of a fully illustrated account of the several classes of Archegoniatæ; there is much that is old and well known interspersed with results of recent work and with interesting discussions as, for example, on the very difficult question of deciding whether certain morphological features should be regarded as reduced or relatively primitive traits. Part II begins with a chapter on Alternation and the Land Habit based on the Huxley Memorial Lecture given by the author in 1929. Chapter xxv—Prothallus and Gametangia—opens with remarks on the gap between the Algæ and the Archegoniatæ: it is disappointing that hardly any notice is taken of the suggestive and original speculations of Dr. Church either in this or in any other section of the book. One would like to know Professor Bower's considered opinion on Dr. Church's dictum that the antithetic theory of alternation is wholly unconvincing and that if anything has been interpolated it is the haploid gametophyte and far back in the benthic phase of the sea.

In the Introduction Professor Bower writes: "the questions for ultimate discussion will be not only the origin of the Archegoniatæ, and their probable relation to the Thallophytic Flora, but also the degree of their affinity with seed-bearing plants, and the part which they have themselves taken in the establishment of a Land Flora." The relation of Archegoniate plants to the Thallophytic flora occupies a very subordinate position in the discussion of possible lines of development of higher from lower forms in contrast to the space devoted to the Archegoniatæ. He speaks of the Archegoniatæ as forerunners of a more advanced land vegetation and says that they "stand aloof from any known Thallophytic origin, unless there be some remote connection with Isokont Green Algæ." It is in this connexion that Dr. Church's hypothesis might well have been critically examined.

It is unfortunate that a mistake made several years ago by the reviewer has misled Professor Bower, who figures an Egyptian fossil as an example of the extinct fern *Clathropteris*, which he says, without any good reason, was probably a Pteridosperm: this supposed fern is almost certainly a piece of a dicotyledonous leaf. The phrase "synthetic type," which frequently recurs, is misleading if taken literally; it should surely be "generalised type." While several extinct plants are called as witnesses, others which are of importance as links in the chain of life are omitted, but it may be unreasonable to expect an adequate comparative study of both the dead and the living in a single volume.

This bulky volume of 646 pages with 465 illustrations, as the author would admit, deals only with part of the story of the development of terrestrial vegetation. We shall never know the story in its completeness. Professor Bower has provided a store of material, well established facts with speculation on their meaning and significance, which will stimulate other botanists to search for clues to the unsolved problem of evolution.

Soldier in Science. By BAILEY K. ASHFORD. (Routledge. 12*s*. 6*d*.)

Here is a fascinating story of a great fight against tropical disease in Porto Rico and elsewhere during the author's thirty-five years of active life. Born in 1873 of British stock settled in Washington and brought up in a Puritan atmosphere, Bailey Ashford inherited the medical urge from his father, a professor at Georgetown University, whose memory was his greatest inspiration throughout his career. After graduating at his father's University he decided to devote himself to service in the medical branch of the United States Army, and was gazetted lieutenant in time for the Spanish American War of 1898, when he served under General Schwann.

The main portion of the book concerns medical research. A type of anæmia, which hitherto had been considered to be due to malnutrition, was endemic in the island of Porto Rico, causing gross deterioration among the natives and producing a heavy mortality. Ashford found in the excrement of these natives a worm closely resembling the *Ankylostomum duodenale* responsible for the anæmia of the workers in the St. Gotthard tunnel; and by the administration of thymol in capsules, which came to be known among the Jibaros as "glass balls," he managed to redeem whole districts by the restoration of health and vitality. The description of his fight for the recognition of the cause of the disease, the gradual building up of the Anæmia Commission, and his struggle to gain the confidence of the patients is a most arresting story.

The section dealing with the investigations in Brazil under the Rockefeller Foundation contains some interesting notes on various tropical diseases, particularly the South American type of sleeping sickness, whose causal insect-carrier was displayed in a somewhat startling manner at the Oswalde Cruz Institute at Rio! The treatment of patients far removed from the well-equipped hospitals, by means of mobile units complete with laboratories, is admirably dealt with; likewise its splendid results.

By the time of the Great War Ashford had risen to Colonel's rank. His description, as a teacher on the staff of the School for American Medical Officers in France, of the medical services of Great Britain and France, from the American point of view, are well interspersed with anecdote. This portion of the book is in some ways the most striking, perhaps especially so the description of Lemaître, the French surgeon, and his work on primary suture. The end of the volume takes us back to the tropics, dealing largely with sprue.

A most interesting and informative book for the general and special reader, provocative of argument in places, but stirring and breezy throughout, it should take a high place among medical autobiographies. The author's death just prior to publication is greatly to be regretted.

The Complete Book of British Butterflies. By F. W. FROHAWK, with a foreword by LORD ROTHSCHILD. (Ward Lock. 10*s*. 6*d*.)

For over half a century Mr. Frohawk has been observing our butterflies. It has taken him nearly half this period to make a complete study of the entire life history of each of the sixty-eight species upon our list. His work embodying the results appeared in 1924, but during the ten years which have since elapsed, a considerable amount of new information has been collected, more particularly in connection with the phenomena of aberration and migration. He now gives us, at a remarkably low price, an accurate picture and a detailed account of all stages of all our British species, including the foreign visitors.

He deals with Haunts, Distribution, Migration, Time of Appearance, Hibernation, Eggs and Egg-laying, Larva, Pupa, Imago, Male and Female, Life of Imago, and Aberration. The entire series is figured in thirty-two coloured plates, and in the

text there are one hundred and sixty drawings of some remarkable aberrations, and pictures of butterflies in characteristic attitudes of rest. All these drawings are marked by the accuracy and beauty which we associate with Mr. Frohawk's work. They are a joy to the eye. Wisely he gives no details of distribution; Mr. Frohawk is not the man to direct exterminators to their fell work. The List of Food Plants is very useful.

Much of the text is very interesting reading, even to the layman. The notes on aberration are stimulating to thought, and the information on migration is remarkable. The author tells us the romantic story of the Great Blue; how he, with Mr. Rayward, solved the mystery of the full grown larva, tracing it to its lair in the ant's nest, when they had the "satisfaction of gazing upon a natural object which had never before been seen by anyone."

It is hard for a man to change the habits of a lifetime, but many will think it a pity that Mr Frohawk advises young collectors to use the old-fashioned bevelled setting-boards. He is modern, however, in that he has adopted the new nomenclature, now an established international rule, that was issued last year by the Royal Entomological Society of London.

Deep Seas and Lonely Shores. By W. L. Puxley. (Williams and Norgate. 6s.)

To the majority the sea is a mere surface, which undulates with distressing results. Any book which opens the door to the life below has value, especially if written in so attractive a style as is Mr. Puxley's.

The author has travelled widely, though I gather he is most familiar with the Australian tropics, and his book contains much strange and out of the way information, on oysters, sea serpents and whales, though tropical fishes form the main interest. For instance it is new to me that the Tile Fish I have known so long from fisheries literature "has a pink head, a dark blue body with gold spots, and beautifully spotted fins," and the way of life of the Fish Tartars will be new to most readers. The taking of the "Frost Fish" in New Zealand is the strangest of all strange ways of fishing, and completely mysterious.

I should like to remind those readers to whom the tropics are inaccessible that temperate seas contain bizarre and beautiful things also, the more interesting because more is known about some of them, though the gaps in our knowledge are wide.

There are serious defects in the book. Could not the author have combined his literary skill and personal familiar knowledge with the more precise knowledge of a zoological collaborator? The result would have been fruitful, and such "howlers," due as much to careless writing as lack of knowledge in some cases, as that a whale needs to open its mouth to breathe, that the pearly nautilus is related to the argonaut, and that the rate of growth of pearl oysters is extremely slow, would have been avoided. Careless writing has resulted in one amusing passage. "Fishing of most kinds known to us is practised by birds and fish. Gannets circle overhead and pounce suddenly like stones falling from a height." I hesitate to recommend this method to any of my own fishermen.

The book is free from the introduction of scientific names without reason, but this can be carried too far. For instance many will wish to know what sort of a thing a "saddle shell" may be, and when dealing with "sea slugs" the real, or scientific names are essential if any meaning at all is to be gleaned. In spite of a lifelong interest in these things I can make very little of pp. 188 to 192. Similarly a very simple classification of the sponges might have been given, and the fact that the commercial sponge is but one form out of hosts of useless species, of astonishing variety and beauty. I have never seen any living sponge "covered with shells and other plants," whatever that may mean.

The few illustrations again are of the "popular" order. Firm and accurate outlines, like definite scientific statements, are more, not less, artistic than vagueness and slight inaccuracy. The master painter is one who is able to combine perfection of detail with its subordination to the main theme, and present a whole which is scientifically as well as artistically correct and complete.

An Eastern Odyssey. By Georges Le Fevre. Translated and adapted by Major-General Sir E. D. Swinton. (Gollancz. 18s.)

This is the description of the Citroën Expedition across Asia which, while mainly a great sporting effort, rendered considerable services to knowledge. It is brightly written and, as the translator is Ole Luk-Oie, the quality of the English is assured. Parts are vivid indeed, and the description of the mediæval assault upon Hami is like an eye-witness account of the storming of a walled city in the Middle Ages.

The party did not consist solely of engineers and mechanics. It included men of such calibre as Father Teilhard de Chardin in charge of the geology, M. Hackin, the orientalist and archæologist, and Dr. Williams, delegate of the National Geographical Society of Washington, as photographer: there was also a cinematographer, and those who, like the writer of this notice, have admired the exhibition of portraits in Paris made by the artist of the expedition, Iacovleff, will agree that the artistic was by no means the least interesting contribution.

Frenchmen are, perhaps, better psychologists than the average Englishman, and seem to have a greater power of penetration under the skin of remote peoples. After reading this book, the Chinese appear less inscrutable, and their motives comprehensible. But as the members were exposed to the policy of "squeeze" and to obstructionism on every side, anti-Chinese feeling is inevitable, and expressed. For the Mongols, however, whom the Chinese regard as barbarians, they have much more friendly feeling.

The portion of the expedition which made its way into Chinese Turkestan through the Pamirs met with such formidable physical obstacles, that it is a marvel that they ever dragged their cars through at all. Through Hunza, even pack horses had to yield to porters. The photo facing p. 108 is indeed impressive. The freshness of the rocks and the rubble brings home vividly the youth of the Himalayas. The elevation is so recent that the fall of débris is still continuing. "The countryside was still in a state of unstable equilibrium," and they passed "under a continuous shower of shale and rock." An inhuman land.

M. Hackin was fortunate in having a cinematographer, artist and photographer, to make permanent record, for at Khara Khoja it seems that the deterioration of the frescoes has reached a critical stage. A comparison of the monuments still in existence with photos taken 20 years ago show how great the deterioration has been. They are crumbling to dust. "A few masterpieces of art . . . likely in 20 years . . . to be reduced to ruins . . . might be preserved from oblivion." This statement is important, as a reply to the chauvinism of the Chinese

who, while resenting the removal to suitable custody of the priceless remains of the past, either will not or cannot take steps to prevent their disintegration.

The book throws interesting light upon conditions in China which encourage the growth of piracy and banditry, and on the Tungan rising. An original point is that the crystallised beauty of art and design in China is regarded as perfection attained, the consequence of which is a total absence of initiative : it "imposes a taboo of rigid tradition on every activity," entirely repressing the genius of the individual. Standardisation was not invented in the U.S.A., but in China, many centuries ago. Hence the Frenchmen found the country "so vast, so drab, so monotonous."

Father Teilhard gives two interesting appendices. One sketches the geological history of the Gobi, the Mongolian Plateau which, despite the persistent Chinese tradition of a sea, has been continental from the very earliest times. There was an eruption of granites and porphyrites towards the close of the Trias, since when denudation has relevelled the present base of the plateau ; then, in early Cretaceous times, began the continuing formation and displacement of closed sedimentary basins, of *gôls* and *nors*. Arid conditions appear before the end of the Secondary era, the prevailing winds forming the vast loess deposits of China. The expedition made it possible to trace a longitudinal section of the plateau, and, with minor modifications, to distinguish several fundamental features. There is a note too on the ridge of the Tian Shan and the Turfan depression.

Another appendix deals with Prehistory. The earliest trace of man in north Central Asia is of the middle Palæolithic, while in the Tarim basin nothing earlier than Neolithic has been found. The generalisation is that Central Asia has never been the birthplace of a civilisation, but only a place of transit, of contact between east and west. Still less has this ancient, arid region been the womb of teeming masses of mankind that have populated the world.

The Prehistory of Scotland. By V. Gordon Childe. (Kegan Paul. 15*s*.)

Professor Gordon Childe's power of collating and arranging a multitude of scattered facts and of deducing intelligible conclusions from them is exemplified afresh in his valuable account of prehistoric Scotland. Here the results of many isolated diggings and casual finds are collated and worked up into a coherent survey from the Stone Age to the end of the Roman period in Britain. To summarise so highly condensed an account is virtually impossible. But the main theme is the gradual colonisation of Scotland in the Neolithic and Bronze Ages from the south-west (Spain) by way of the Atlantic and from the east (Scandinavia and North Germany) across the North Sea. These rival influences account for the wide differences in the archaeological remains in the several coastal regions of Scotland. At first the population was very small. Immigration on a larger scale began in the later Bronze Age, but even then the local differences remained. Professor Childe emphasises his familiar warning against the tendency to assume that the several periods into which, for the sake of convenience, we divide prehistory were absolutely distinct and marked by social cataclysms. The introduction of bronze certainly did not involve the disuse of stone tools, nor did the introduction of iron imply the discarding of bronze weapons—especially in Britain where tin and copper were plentiful. Apart from new inventions, there is plenty of evidence to show that invaders adopted in some cases the burial customs of the alien people among whom they settled. Professor Childe in his methodical way throws much new light on the difficult problems of Scottish archaeology—such as the brochs of the North, and the "earth houses." In his closing pages he suggests that the Picts—those mysterious people whom the Romans certainly knew, but who vanished before recorded history begins—lived both in Ireland and in Scotland, lived in "earth houses," and were probably the Celtic "Pretanni" or Britons whom the Greek Pytheas encountered or heard of in the third century before Christ. The work is fully illustrated and well documented, and contains five archaeological maps which, if carefully studied, will confirm the general accuracy of the author's conclusions. With Professor Childe's excellent treatise as a new starting point, Scottish scholars should be able to find out a great deal more about the subject.

Flying Girl. By Elly Beinhorn. (Geoffrey Bles. 16*s*.)

There are some people, and I count myself among them, who can welcome any book of travel for its information, however slender, and for the personality of the writer which shows itself on every printed page. But how much better it is to travel than to arrive ! and how willingly do I subscribe to the opinion of Jan and Cora Gordon when they declare travelling by fast train or aeroplane "as so much time lost out of life."

Miss Elly Beinhorn has flown round the world and this book is the story of her flight. For a young girl this act was courageous enough and since she flew a small machine it was probably of some value to German aviation. But it does not make a book of travel, and since, fortunately enough, the flight was not particularly hazardous, it does not make a book of adventure. An aeroplane has no time for travel for it is always arriving, and having arrived, is always setting off again. In its own parlance, it hops from one stage to another and unless it crashes there is very little chance of excitement or adventure.

We must fall back, therefore, on the pleasures of the author's personality but here, alas, we are checked again ; the book is so obvious a translation. This is a serious drawback for in spite of their aeroplanes both Mr. K. C. Gandar Dower in his "Amateur Adventure" and Mr. Halliburton in "The Flying Carpet" succeeded in interesting their readers on the strength of their personalities and their particular observations. Miss Beinhorn, although attempting some, has not sufficient perspicacity for serious comment. That she has a strong personality I have no doubt. She is the Mrs. Mollison of Germany and on enquiry the other day I was confidently informed by a young German that she was only slightly less popular than Hitler, an opinion which at least betrayed his own political sympathies. There is, indeed, no note to say that this book is a translation, but I feel confident that it is, and even if it is not the book must first of all have been thought out in German.

I feel, perhaps, that I have been unkind and that many readers who still believe that a flight is sufficient reason for writing a book about it, will find much to entertain them while they accompany Elly Beinhorn round the world. But the book has too many imperfections to praise unreservedly and in a small space I must point these out. Some of the pictures are good, but there are no maps, and when one is travelling in an express train and reading, as I was, it is not encouraging to read, "Now please take an atlas and examine the map of Syria—as large-scale a map as you can get hold of."

The Nature of a Bird's World. By ELIOT HOWARD. (Cambridge University Press. 7*s*. 6*d*.)

This book (like Caesar's Gaul) is divided into three parts, headed respectively: "Of its physical basis," "Of its division into different worlds," and "Of its relation to learning." In the first of these the author argues that the bird's reactions to physical sexual changes are an organised whole. In the second he describes how a bird lives in a territory world, a sexual world, a nesting world, a brooding world—"just as we have many worlds so has a bird." In the third the author restates and to some extent modifies, his territorial theory, which has, indeed, been often imperfectly understood and sometimes unintelligently attacked. "Territory," he says, "is not merely localised space, it is the objective aspect of a bird's subjective state; it is action on the part of the bird from which emerges shape, size, position and duration." The last three are provided by the bird's inherited organisation. But shape is individual.

Mr. Howard tells us in the preface that in this book he seeks the nature of a bird's world, not with any hope of finding it, but to know what to find. "Mysteries will be mysteries still. I would not change it." And, again, "To solve a problem," he says, "is a vain delusion." Mr. Howard's quest will never end. A book by him will always be an event, for it will mark a step forward. And this adventurous quality in his work attracts not only scientific ornithologists, but those who are content to watch and enjoy birds without any theory.

The Two Sources of Morality and Religion. By HENRI BERGSON. (Macmillan. 10*s*.)

Before indicating the extreme interest and importance of M. Bergson's mature thought, it is right to give a word to the remarkable excellence of this translation. The reviewer had already read the book in French and was therefore able to make a thorough comparison. The rendering is not only faultless, but has the exceptional merit of reading as an English work. The highest praise is due to all the translators whose names adorn the title page.

It is quite clear from the general planning of the book and the pointed remarks of the last chapter, that M. Bergson has thought of it throughout, not, we will hope, as a swan-song, but as a summary and application of his deepest thought towards the solution of what he feels to be the most pressing problems of his generation. Some of us may think that he takes an unnecessarily gloomy view of them. None of us would question but that there is much to be said for the apprehension which he feels at certain features. What then is the main point in his solution? It is the re-cultivation, at a higher level and with the fresh lights of later science, of the spirit of mysticism or of the absorption of the individual in the universal Spirit of Life and Love which he finds best exhibited in the mystics of the Christian tradition. Such an attitude, generally diffused, seems to M. Bergson the only prophylactic against the machine, with its accompanying spread of material luxuries which is the worst danger of the age. Such is the conclusion; but to most readers the more suggestive, certainly the more original, part of the book will seem to be the earlier and much fuller psychological-historical analysis which leads up to the author's re-statement of religion. The strong points far outweigh those on which some very natural scepticism will be felt by logically trained readers. A short indication of both these sides is all that can be attempted here. On the credit side, Bergson's view will command general support from the fact that he lays the main stress on the historical, biological, and evolutionary standpoint in discussing both moral and religious questions. In this matter he places himself at the central and most comprehensive point from which thinkers of the day regard the universe. He has, of course, himself done much to create this attitude. Life in all its aspects is the background of all his thought, and he finds in the evolution of life the only possible centre for a synthesis of thought and life in the future. He is also on strong ground when he discriminates between what he calls the "closed" systems of life which take the form of what appear to us arrested instincts, and the "open" systems of which humanity is the capital example. The elaboration of this distinction fills the earlier and larger part of the book and is, of course, a sequel to the same thoughts thrown out in *L' Evolution Créatrice*. It leads in this work to a further distinction between what he calls Static and Dynamic Religions. The latter find their natural consummation in mysticism as he defines it. So far, so good. Where, however, M. Bergson will meet more doubts and disagreements is in the too sharp lines that he is constantly drawing between the different types of vital activity which he describes. We must be ready to admit much more constant and infinite variations and not to oppose as he does "intelligence" to instinct, or "static" to "dynamic," with the same picturesque emphasis. No doubt this strongly pictorial and figurative method adds much charm and effectiveness to the book, but it has its obvious dangers and here and there the author throws out a phrase to show that he is himself fully aware of them. No one, moreover, can truthfully find all the religious inspiration and advance, either in the Middle Ages or at any time, in the individually gifted souls who break away from the general level. More allowance must be made for "Das Gemeine," though, among those who deeply stir their contemporaries, reveal to them their real needs and show the way for further advance, M Bergson himself will stand high on the roll of fame.

Creation and Evolution in Primitive Cosmogonies and other Pieces. By SIR JAMES FRAZER. (Macmillan. 8*s*. 6*d*.)

Sir James Frazer has here brought together a small collection of miscellaneous papers which have already appeared elsewhere at various times. The "piece" which gives its title to the whole originally was a contribution to the volume celebrating the fiftieth anniversary of the publication of *The Origin of Species* in 1909. It is apposite as an assembly of beliefs or primitive peoples which show that while many believe in a special act of creation as the origin of the universe, others in almost equal numbers hold theories which might be termed evolutionary. A second major contribution to these collected papers is the Zaharoff Lecture on Condorcet which was delivered by Sir James in Oxford in 1833.

Among the remaining pieces may be mentioned for their strong personal interest two graceful notes on the author's friends and fellow workers through many years, Sir Baldwin Spencer and the Rev J. Roscoe, and reminiscences of the author's early life in Glasgow and of his parents and family connections.

It must be confessed that while this material might well appear as part of a collected edition it is slight for a single independent volume. The author's many admirers, however, will here once more enjoy the charm with which he invariably adorns every subject to which he may set his pen.

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